PRYOR

Food Problems and Prospects In Sub-Saharan Africa

The Decade of the 1980's

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FOOD PROBLEMS AND PROSPECTS

IN

SUB-SAHARAN AFRICA

THE DECADE OF THE 1980's

September 1980

FOREWORD

This study grew out of discussions between the International Economics Division of ESCS and the Africa Bureau of AID on the need for a comprehensive analysis of the current and future food situation in Africa. The study addresses one of the most critical of world food problems in the 1980's: seriously declining per capita food production in Sub-Saharan Africa, its causes and consequences, and the prospects for increasing the availability of food over the next decade.

Chapter I looks at the long-run trends in food production, consumption, and trade for the region as a whole. Chapter II analyzes the structure of demand in the region, and the policies which affect it. Chapter III discusses the multiple constraints to increasing food production in Sub-Saharan Africa. Chapter IV discusses, on a regional basis, the policies which affect the food supply and its marketing. Chapter V contains new projections of food demand and supply for each region, and for Sub-Saharan Africa as a whole, and compares these projections with estimates made earlier by various organizations--U.S. Department of Agriculture, United Nations Food and Agriculture Organization (FAO), the International Food Policy Research Institute, and others. Chapter VI presents conclusions. A more technically oriented documentation of the model and data base will be available on request.

Cheryl Christensen, Chief of the Africa and Middle East Branch, directed the overall preparation of the study, and drafted portions of the manuscript. Art Dommen organized the discussion of the physical constraints to increased food production, and drafted the section dealing with this topic, with the assistance of Sarah Lynch.

Shahla Shapouri specified and estimated the model, made the projections and ran the scenarios. Shirley Pryor coordinated the discussion of policies and drafted sections of the text. Regional chapters were drafted by Nadine Horenstein (Sahel and West Africa), Peter Riley (East and Southern) and Herb Steiner (Central). Information on policies was provided by country experts of the Situation and Outlook section--Charles Treakle, Larry Witucki, Margaret Missiaen, Mike Cullen and Herb Steiner. Kevin Lanagan organized and directed the collection and computerization of data. David Skully, Mary Burfisher, Mike Williams and Suzanne Rodbell collected and cleaned data. David Stallings and Sam Calhoun, World Analysis Branch, assisted in computerization. Montrue Polen, Linda Mitchell, Bernardine Holland and Deloris Midgette typed the manuscript and its numerous drafts.

The study benefitted also from insights gained by Vernon Johnson, Harold Jones, and Cheryl Christensen during a visit to several food-deficit African countries in May of this year.

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EXECUTIVE SUMMARY

Sub-Saharan Africa is the only region in the world where per capita food production declined over the past two decades. This decline exacts a high price in both human and economic terms. The human price is inadequate nutrition. In most Sub-Saharan countries, per capita calorie intake falls below minimal nutritional standards. The economic price of inadequate food production is an increasing demand for food imports at a time when grain prices are rising and many African governments face acute balance of payments and foreign exchange problems.

Our study finds that the implications of this pattern are severe. Using a series of equations which capture the dynamics underlying production and consumption between 1965 and 1975, we estimated import demand and unmet food needs in 1990 if historical trends continue. The picture is a stark one. If 1975 real per capita income levels and producer price patterns prevailed in 1990, Sub-Saharan Africa would have an import gap of 11.5 million metric tons (cereal equivalent). High as this is, there would still be large unmet food needs. Bringing diets up to minimal calorie consumption levels (about 2300 calories per person per day) would require 12.4 million tons, more than the total import demand.

Ordinarily, the assumption that per capita income remained at 1975 levels would be considered a pessimistic one, designed to show primarily the growth in import demand associated with population growth. Our study suggests, however, that for many countries, this may be an optimistic assumption. Real per capita income declined in all regions of Africa between 1975 and 1979. If real 1979 per capita income levels and producer price patterns prevailed in 1990, the import gap would fall to 9.5 million tons, while unmet food needs would rise. Some 13 million tons would be

required to attain minimal calorie consumption levels.

Even if we assume that there is growth in real per capita income, and that growth follows 1965-79 patterns (essentially smoothing out the effects of recent economic problems), the picture is disturbing. The import gap rises to 18.5 million tons--some 11.9 million tons being accounted for by West Africa alone. Because income growth is so skewed across regions, diets reach adequate levels in West Africa, while major unmet food needs persist in the Sahel, Central and East Africa. Meeting these needs would require an additional 9.1 million metric tons of cereals. If growth followed more recent 1974-79 trends, the regional skewing is even more extreme. Under these conditions, the 1990 import gap would be 21.1 million tons--with 18.2 accounted for by West Africa. Unmet food needs would persist, and 10.1 million tons would be required to eliminate them. The conclusion seems clear. If growth follows historical patterns, there will be dramatic increases in the paying demand for imports by 1990, yet very little reduction in the quantity of food required to respond to unmet food needs.

Why is Sub-Saharan Africa's food balance so precarious? Much of the problem lies on the supply side. Productivity has been low, and growth in production has depended primarily on increases in acreage. To some extent, this reflects the structure of food production. While land tenure patterns vary from region to region, most food production occurs in the subsistence sector. There is little use of commercial inputs which might improve yields, and most of labor for cultivation is provided by people working with relatively simple hand tools. Labor requirements, and as importantly labor bottlenecks, put constraints on the additional acreage which can be cultivated.

In addition, however, the natural environment plays an important role. Wide variations in yield occur, reflecting adverse weather, pest infestation and crop diseases. Many tropical soils are fragile, losing organic matter

and nutrients quickly if they are exposed or cultivated intensively. Cropping patterns and fallowing systems have been the major vehicles for managing soil fertility. Yet, if African food production is to increase, ways must be found to make a transition both to a more commercial system of production and marketing, and to viable methods for more intensive cultivation with higher yields.

Knowledge of African food production systems is spotty, and has not led to the development of viable packages of inputs based on new technology such as have been developed in Asia and elsewhere. The environmental obstacles to such new technology are enormous. In addition, the conditions of labor scarcity and labor bottlenecks in which food production takes place in Africa make the search for viable technology difficult. On the whole, better use of existing resources seems to offer, at the present time, a surer means of improving productivity until a redirected research effort can come to grips with the real constraints facing African farmers.

Part of the problem lies with the structure of demand, however. In many countries, there is a high demand, especially in urban areas, for wheat and rice. Wheat cannot be produced in many countries, while rice production is frequently more difficult and costly than production of other, less preferred, crops such as millet, sorghum, maize, pulses, roots and tubers. In some areas, attempting to reduce the import gap may mean shifting dietary preferences. In others--especially West and East Africa--it may depend more on developing ways of processing local foods to make them more convenient to urban consumers who still have taste preferences for them.

Historical orientations and policies have also contributed to creating existing conditions. Agriculture and its support system have been, and to a great extent remain, geared toward export crop production. Cash crops are

generally produced primarily for external markets. Internal urban markets are often supplied through imports, sometimes because it is less expensive for countries to import food than to encourage domestic production and bear high internal distribution costs. Changing this emphasis will require substantial investment in infrastructure and institution building.

The success of any move to transform domestic food production will be extremely dependent on the timing and coordination of marketing, production and trade policies. Our analysis of the 1965-79 period suggests that production is responsive to price in all regions except Central Africa. Pricing policy can, therefore, be an instrument for increasing food production. Changing pricing policy will not, in and of itself, solve the problem, however. Pricing policies are ineffective unless the transportation system is adequate. In addition, storage facilities may be necessary to support an announced pricing policy.

In the short term, the right mix of trade, marketing, price and storage policies, put into effect by governments who have become conscious of the consequences of the food problem, may create an incentive for farmers to produce more food.

Unless there are structural changes in productivity in food production, however, there will be a point where greater production of one commodity can come only at the expense of decreased production elsewhere. Under these conditions, the tradeoff between food crops and traditional export crops rapidly assumes the character of direct competition for land and labor resources. Governments are able to influence the outcome of this competition through their pricing policies (inputs and outputs), but they are constantly pressured to influence it in favor of cash crops where the latter account for a heavy share of foreign exchange earnings.

In the longer perspective, therefore, the timing of implementation of agricultural and other related policies becomes critical. In the absence of incentives for farmers to adopt new farming practices and technology, government investments in agricultural research, extension services, and input delivery systems will have only a small payoff, quite inadequate to deal with the scope of the food problem. On the other hand, the application in an ad hoc manner of policies creating incentives to farmers produces unexpected and costly results if the physical foundation for higher productivity has not been laid.

It is probably unrealistic to expect that the countries of Sub-Saharan Africa can find the resources and new technology to eliminate the huge import gaps that characterize the economies of many of them today. They can narrow these import gaps. Doing so requires a combination of workable policies and investments in productive infrastructure and upgrading human capital leading to a transformation of their subsistence sectors from present low levels of productivity and quality of life to higher levels of productivity and quality of life.

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LIST OF ABBREVIATED TERMS AND ACRONYMS.

AVV	Autorité des Aménagements des Vallées des Volta
CFA	Communanté Financière Africaine
CILSS	Comité Inter-Etats pour la Lutte Contre la Sécheresse dans le Sahel
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CRED	Center for Research in Economic Development
CSIR	Council for Scientific and Industrial Research (Ghana)
DEVAG	[Department of Agricultural Development] (Zimbabwe)
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
FMG	Malagasy Franc
FIS	Food Investment Strategy (Senegal)
GNP	Gross National Product
IBRD	International Bank for Reconstruction and Development
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFC	International Food Council
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
INEAC	Institut National pour L'Etude Agronomique au Congo
IRAT	Institut de Recherches Agronomiques Tropicales
IRRI	International Rice Research Institute
ITFL	Individual Tenure Farm Land (Swaziland)
MOIRA	Model of International Relations in Agriculture
MPGE	Maximum production of grain equivalents
NAFPP	National Accelerated Food Production Programme (Nigeria)
OAU	Organization for African Unity

OFN	Operation Feed the Nation (Nigeria)
PCE	Private Consumption Expenditure
P.L. 480	Public Law 480, Food For Peace
RSA	Republic of South Africa
RTP	Roots, tubers, and plantains
SATEC	Société d'Aide Technique et de Coopération
SNL	Swazi Nation Land (Swaziland)
SODERIZ	Société pour le Développement de la Riziculture (Ivory Coast)
TTL	Tribal Trust Lands (Zimbabwe)
UN	United Nations
UNCC	Union Nigérienne de Credit et de Coopération (Niger)
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WARDA	West African Rice Development Association

MEASURES

ha. = hectare

kg. = kilogram

km. = kilometer

mm. = millimeter

mt. = metric ton

CHAPTER I. OVERVIEW

THE FOOD PRODUCTION RECORD AND ITS IMPLICATIONS

Sub-Saharan Africa is the only region in the world where per capita food production declined over the past two decades 1/ (fig. 1). A few countries improved on the record of the early sixties. Most, however, showed moderate to severe declines (table 1). In 1978, per capita food production in Angola, Benin, Ethiopia, Ghana, Nigeria, Zimbabwe, Senegal, Sierra Leone, Uganda, and Upper Volta was less than 90 percent of the 1961-5 average.

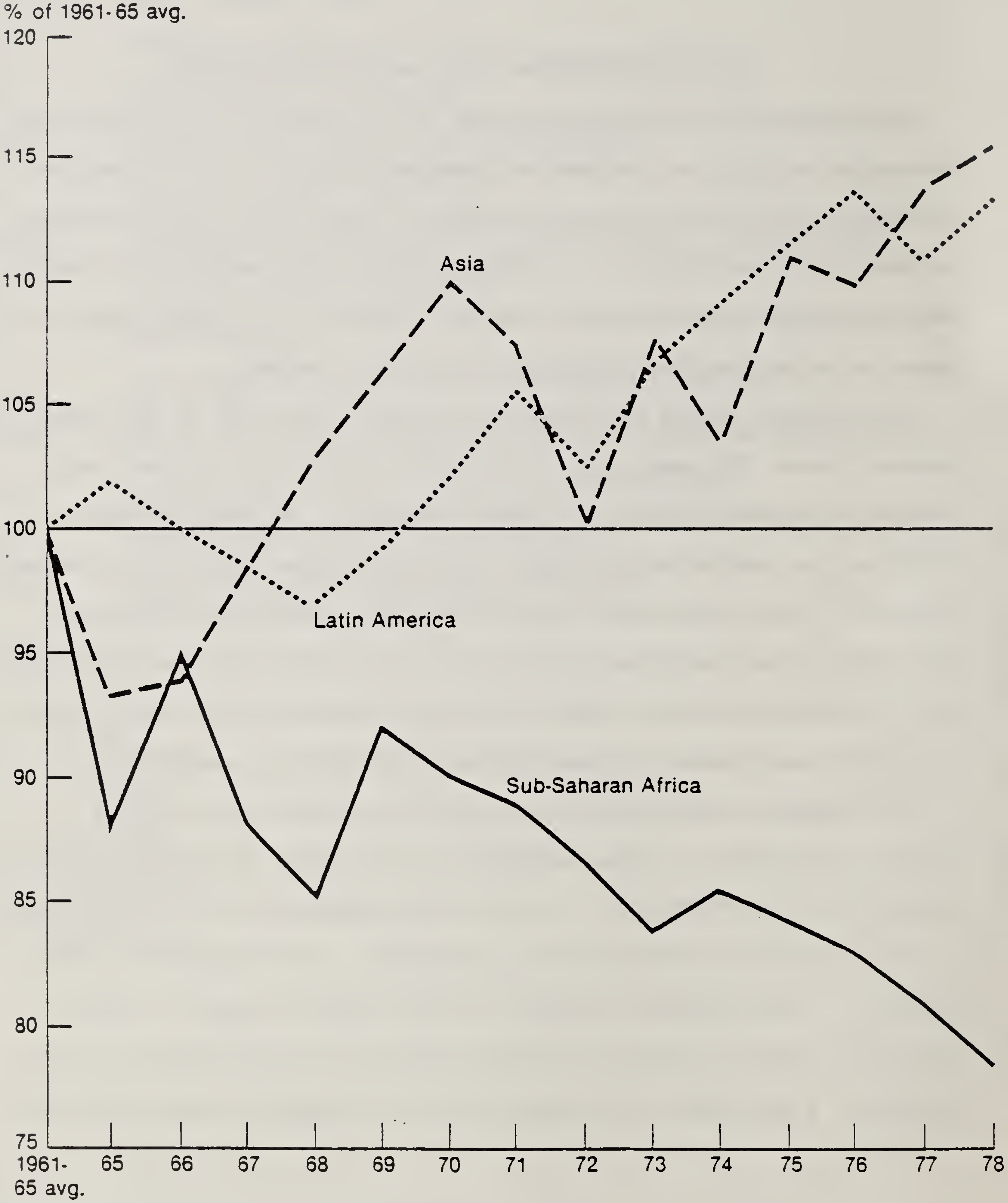
Declining per capita food production exacts a high price in both human and economic terms. The human price is inadequate nutrition. The most basic measure of adequate nutrition is calorie intake. 2/ In most Sub-Saharan countries, per capita calorie intake falls below minimal nutritional standards (table 2). Even if the total food available were distributed equally and efficiently, there would not be enough to give everyone an adequate diet. In the 18 countries where per capita calorie availability is less than 90 percent of minimal requirements, serious nutritional problems are unavoidable.

The aggregate food supply is not generally divided equally among a country's population. Hence, estimates of the portion of population which is chronically malnourished vary. In 1970, FAO estimated that 67 million people, or about one fourth of Africa's total population, had an inadequate calorie supply. 3/ This estimate is likely to be low, however because it does not take into account the impact of income inequality on the allocation of food supplies. A World Bank study which explicitly considered income distribution

Figure 1

Sub-Saharan Africa

Index of Food Production per Capita



Source: ESCS Indices of Agricultural Production.

Table 1--Indices of per capita food production, Sub-Saharan Africa, 1970-79

Region and country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979 1/
					1961-65=100					
Sahel:										
Mali	84	86	65	67	86	88	97	82	105	75
Niger	104	109	105	66	91	76	103	92	106	85
Senegal	64	87	56	68	90	100	87	59	88	68
Upper Volta	76	70	66	58	72	76	74	67	69	67
West Africa:										
Benin	92	89	88	93	89	84	85	88	89	82
Cameroon	97	102	97	93	97	96	97	96	97	97
Ghana	99	93	81	87	88	75	74	71	68	70
Guinea	107	110	109	108	98	94	101	93	102	101
Ivory Coast	107	113	105	109	120	142	129	125	128	132
Liberia	81	84	84	91	100	94	96	98	96	97
Nigeria	95	93	95	87	90	89	88	86	84	84
Sierra Leone	93	98	96	95	92	96	92	95	87	82
Togo	108	103	102	96	98	96	97	93	97	96
Central Africa:										
Angola	104	95	88	95	92	72	65	58	53	51
Zaire	119	109	106	112	107	105	106	103	97	97
East Africa:										
Burundi	117	119	119	117	98	113	110	109	108	109
Ethiopia	99	99	91	87	84	67	63	58	52	54
Kenya	96	91	99	97	96	102	113	117	111	110
Rwanda	123	122	115	118	112	121	119	121	119	119
Sudan	110	115	107	101	114	125	122	123	129	123
Tanzania	102	104	100	101	114	117	99	98	100	105
Uganda	95	92	87	82	79	81	77	73	76	68
Southern Africa:										
Madagascar	108	107	107	98	102	105	105	107	108	99
Malawi	96	108	118	109	110	97	101	95	96	90
Zambia	95	117	132	110	135	139	153	142	128	104
Zimbabwe	79	93	103	78	102	92	88	86	83	69

Source: U.S. Dept. Agri, Econ., Stat., Coop. Service, Indices of Agricultural Production, 1970-79.
1/ Preliminary

Table 2--Calories per capita, selected countries in Sub-Saharan Africa, 1977

Region and country	Percentage of nutritional requirements	Region and country	Percentage of nutritional requirements
	Percent		Percent
Sahel:		Central Africa--Con.	
Chad	74	Congo	103
Gambia	--	Equatorial Guinea	--
Mali	90	Gabon	--
Mauritania	86	Zaire	--
Niger	91		
Senegal	95	East Africa:	
Upper Volta	79	Burundi	97
		Ethiopia	75
West Africa:		Kenya	88
Benin	98	Rwanda	98
Cameroon	89	Somalia	88
Ghana	86	Sudan	--
Guinea	84	Tanzania	93
Guinea-Bissau	--	Uganda	91
Ivory Coast	105		
Liberia	104	Southern Africa:	
Nigeria	83	Botswana	--
Sierra Leone	93	Lesotho	99
Togo	90	Madagascar	115
		Malawi	90
Central Africa:		Mozambique	81
Angola		Zambia	87
Central African Republic	99	Zimbabwe	108

Source: World Bank, World Development Report, 1980.

estimated that in 1975 about 193 million people--more than 60 percent of Africa's total population had a seriously inadequate calorie intake. 4/ To compensate for the effects of income inequality, about 10 percent more food would be needed to provide an adequate per capita calorie intake. 5/

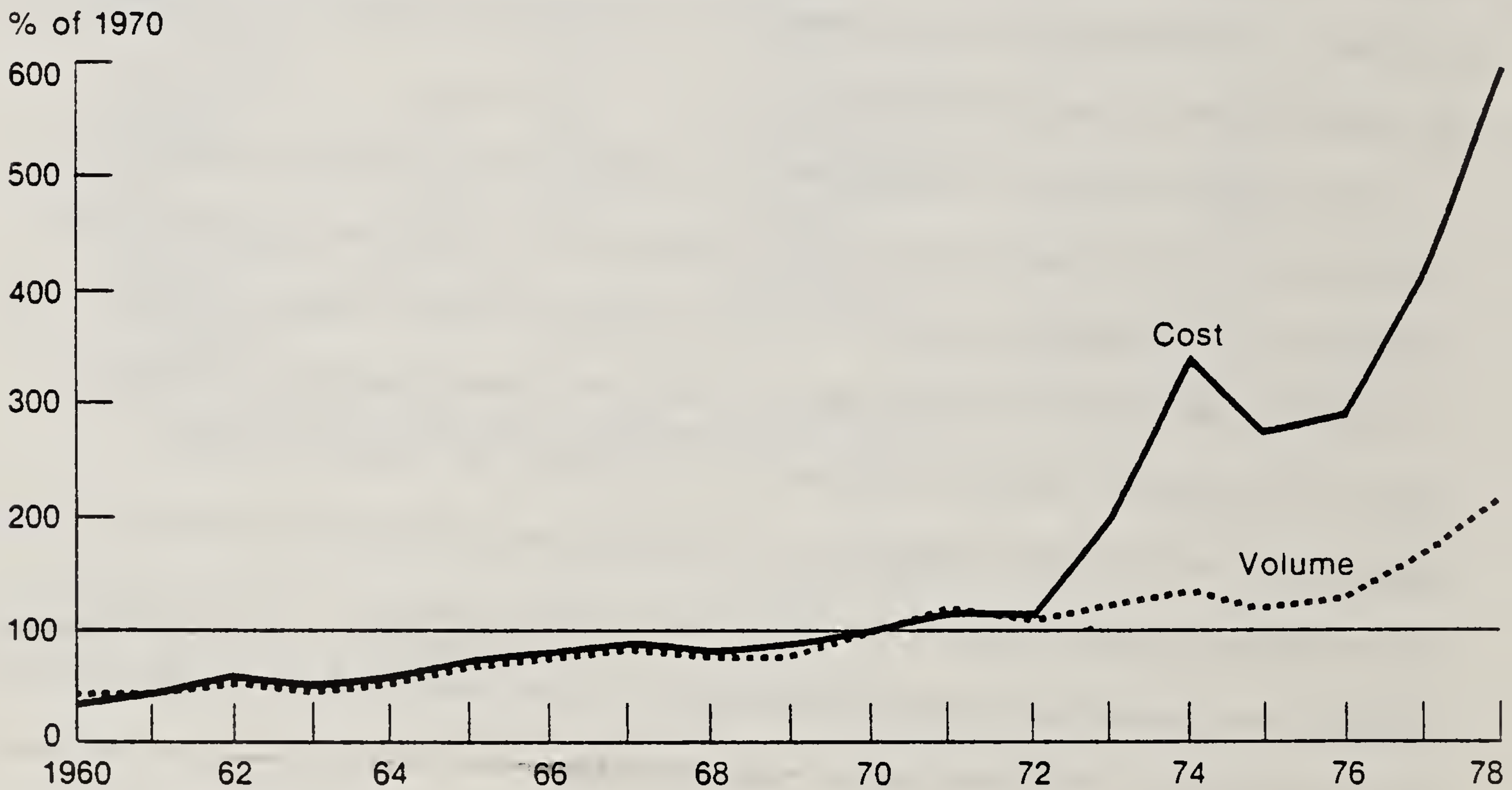
Declining per capita food production coupled with chronically inadequate calorie intake means there is little margin for human error or natural disaster. Drought, political turmoil or errors in policy can produce major food crises which threaten many with starvation. Famines in the Sahel and Eastern Africa over the past decade make this all too obvious. If the historical pattern of food production continues, responding to emergencies will take a larger share of the financial resources of both African countries and international food aid programs.

The economic price of inadequate food production is a rising import bill. Governments in Sub-Saharan Africa have responded to inadequate domestic food production by increasing imports. Cereal imports tripled during 1960-79 (fig. 2). During the sixties, grain imports imposed little financial hardship. While the volume of imports doubled, the cost rose by only 50 percent. Stable, low grain prices combined with concessional sales made imports a cheap and relatively secure way of meeting growing urban demand. In the seventies, however, the situation changed dramatically. The cost of Sub-Saharan Africa's cereal imports in 1978 was double that of 1970.

The food situation just described would be serious in almost any international economic environment. It is particularly ominous now, however, since many African countries have been experiencing severe balance of payments problems as a result of recent international economic changes. African countries are usually exporters of primary commodities. Even the largest of

Figure 2

Sub-Saharan Africa
Indices of Grain Imports: Volume and Cost

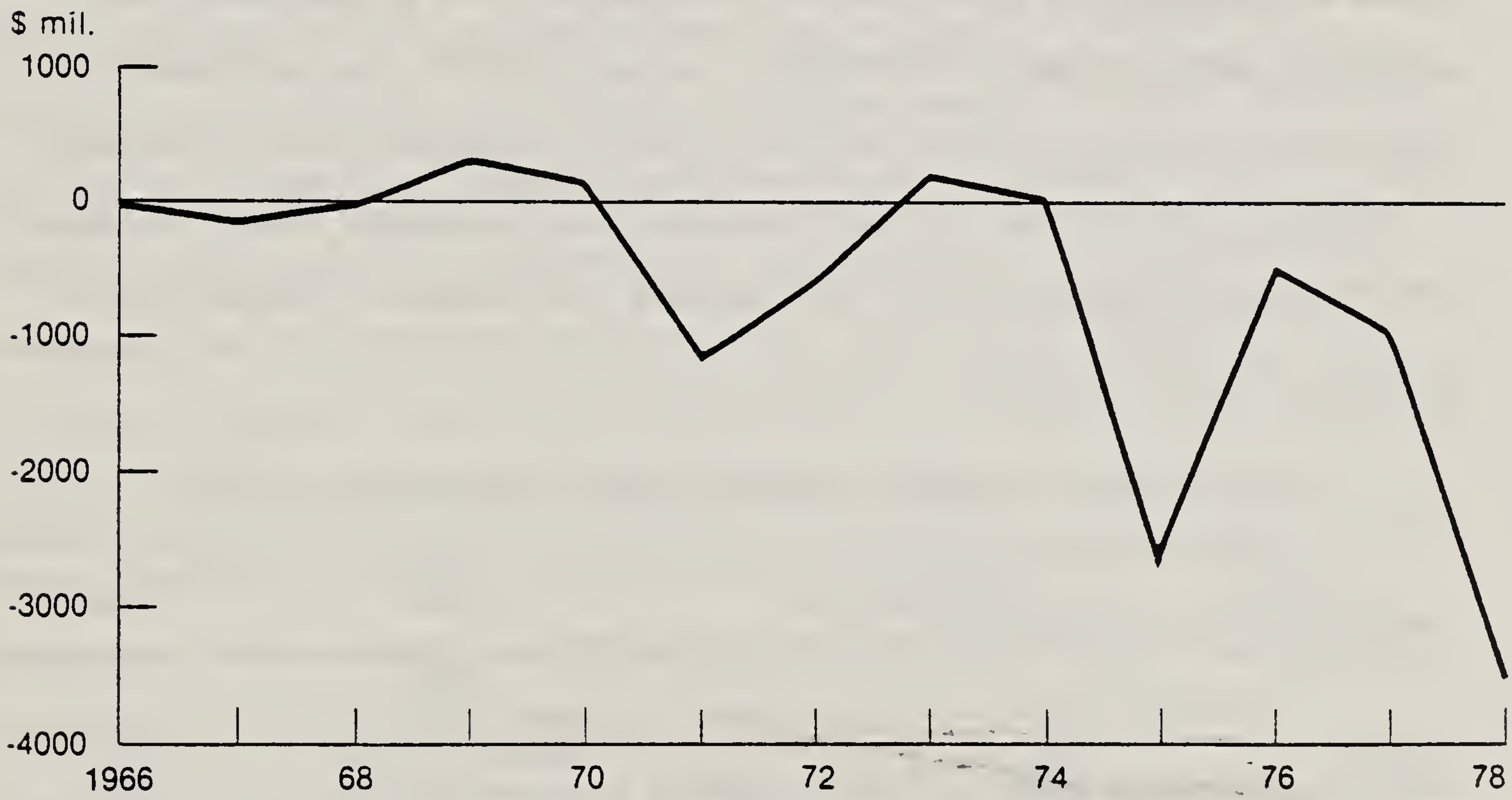


Source: FAO Trade Yearbook.

Figure 3

Sub-Saharan Africa

Balance of Trade



Source: UN Monthly Bulletin of Statistics. Note: Excludes Nigeria.

the foreign exchange earners depend on a few unprocessed products (table 3). With the exception of oil, these commodities' prices have not kept pace with the increased cost of key imports. Short-lived booms in coffee, sugar, and copper temporarily boosted some states' earnings but have not offset the rising cost of imports. Hence, the balance of trade for Sub-Saharan Africa (excluding Nigeria) moved from a small surplus in 1970 to a massive deficit in 1976 (fig. 3).

Financing food imports is more difficult not only because real grain prices are higher, but also because other imports such as petroleum and industrial goods are much more costly. During 1970-79, the real price of wheat rose 153 percent, while the real price of petroleum rose 757 percent. 6/ Without major changes in their prospects for increasing export earnings, many Sub-Saharan countries will find growing food imports a serious strain on their limited resources.

Table 3--Major foreign exchange earners, Sub-Saharan Africa

Country	Major exports	Value	Year
		US$	
Nigeria	Oil	19,049,370,930	1979
Ivory Coast	Cocoa, coffee, timber	2,660,945,274	1979
Gabon	Oil, manganese, timber	1,830,149,254	1979
Kenya	Coffee, refined petroleum, tea	1,109,490,643	1979
Angola	Oil, coffee, diamonds	1,100,000,000	1978
Ghana	Cocoa, timber	961,603,680	1977
Zambia	Copper	844,816,000	1978
Zaire	Copper, cobalt, diamonds	772,790,467	1978
Senegal	Peanuts	650,031,881	1977
Liberia	Iron ore, rubber, diamonds	536,570,000	1979
Sudan	Cotton	505,750,000	1978
Tanzania	Coffee, cotton	490,229,133	1978
Congo	Oil	193,666,312	1977

Source: International Monetary Fund, International Financial Statistics, various issues, except Angola, USDA/ESCS, Agricultural Situation, Review of 1979 and Outlook for 1980; Africa & West Asia (August 1980), p. 4.

In addition, Sub-Saharan countries may have to compete for food supplies in tighter, less stable, global markets. Global cereal markets once characterized by assured supplies for commercial and concessional sales are in a state of transition. 7/ Several forces are at work. First, commercial demand for grain imports is increasing among middle income LDCs, as well as in Eastern Europe and the USSR. Growing demand will, tightenthe markets, other things being equal. Second, some experts now think U.S. agriculture is in "rough equlibrium": without the chronic surplus capacity which characterized the last several decades. 8/ This implies that American surplus stocks will not insulate future world market prices from the impact of weather as effectively as they did in the past. 9/ Greater uncertainty about the price and even availability of cereal imports introduces an element of risk, which African leaders need to incorporate into calculations of the "comparative advantage" they may historically have had in export crop production. 10/

Third, financial conditions in major industrial countries limit the growth of aid. Unless there a major change in policy--like that recommended by the Brandt Commission, foreign assistance will not keep pace with global inflation. Under these circumstances financing concessional food sales may become more of a problem. Finally, another shift in global markets is possible if major grain producing countries find it politically and economically attractive to generate a portion of their energy requirements from foodstuffs. 11/

Virtually all attempts to project Africa's import requirements conclude that unless there are major changes in domestic production trends, the situation will become much worse during the 1980s. If domestic production

trends continue, Africa's demand for food imports will be two to three times its present level by 1990, even without significant income growth. The International Food Policy Research Institute (IFPRI) estimates that historical rates of growth in domestic food production, coupled with a constant 1975 level of per capita income, would produce a 1990 cereal import demand of 17 million tons--roughly three times 1979 levels. 12/ FAO's trend analysis, based on more optimistic assumptions about domestic food production and income growth, estimates an import demand of 12 million tons by 1990. 13/ Neither projection, however, accounts for the impact of food prices on demand and supply. Trend analysis, which includes these price effects, suggests a deficit of about 11.5 million tons by 1990 if real per capita income and domestic food prices are kept at 1975 levels.

Large as this import demand may seem, it still leaves a significant calorie gap--the difference between the demand for food, and the quantity necessary to meet minimal calorie intake requirements. 14/ The calorie gap for projections based on constant 1975 income slightly exceeds the projected import demand. IFPRI estimates the calorie gap to be the equivalent of 13 million tons in 1990, while FAO estimates 8 million tons. 15/ Our estimates suggest that 12.4 million tons will be required.

However, for some African countries, even maintaining per capita income at 1975 levels may be an optimistic scenario. Based on 1974-79 trends, real per capita income is projected to decline in both the Sahel and Southern Africa, while West Africa (primarily Nigeria) would experience strong real income growth. Under these conditions, the import demand for food in Sub-Saharan Africa would rise to 21.1 million tons (wheat equivalent). However, West

Africa would account for 86 percent of the import demand. Because growth is concentrated in West Africa, even this dramatic increase in paying demand does little to reduce the calorie gap, which now amounts to 10.1 million tons. 16/ Without major efforts to supplement commercial purchases, diets would remain inadequate in the Sahel, Central, and East Africa. On the other hand, if 1990 income did not rise above real 1979 levels, the import demand would drop from 11.5 million to 10.2 million tons.

A significant increase in per capita income, on the other hand, would increase the demand for cereal imports. IFPRI estimates that modest per capita income growth, with no change in domestic food production growth rates, could swell the demand for imports to 37 million tons by 1990. 17/

BACKGROUND ON THE FOOD BALANCE IN SUB-SAHARAN AFRICA

Why is Sub-Saharan Africa's food balance so precarious? One possible explanation would be that the continent faces a "demand problem" where rapid population growth overwhelms significant improvements in agricultural productivity. This is not the case, however. While the population growth rate of Sub-Saharan Africa is high, there has been poor growth in productivity and aggregate food production. Therefore, much of the problem appears to be on the supply side. Increasing population and rapid urbanization, then, exacerbate major weaknesses which already exist in African food production and distribution systems.

Sub-Saharan Africa's population growth rate has increased steadily over the past 20 years--from 2.05 percent in the mid-fifties to 2.74 percent in the

late seventies (fig. 4). It now has the highest rate of population growth of any of the developing regions. Furthermore, population growth rates are projected to remain high over the next decade. According to United Nations projections, Africa is the only developing region where population growth rates will continue to increase throughout the 1980s. 18/ They are not expected to level off until about 1990, when they will average about 3 percent per year.

Over the next decade, attempts to slow population growth rates will have relatively little impact on the demand for food. Most of the population impact on demand is built into the structure of the present population.

A clearer demand problem is posed by urbanization, since the interaction between urbanization and income growth creates a structure of demand which is often difficult to supply from local resources.

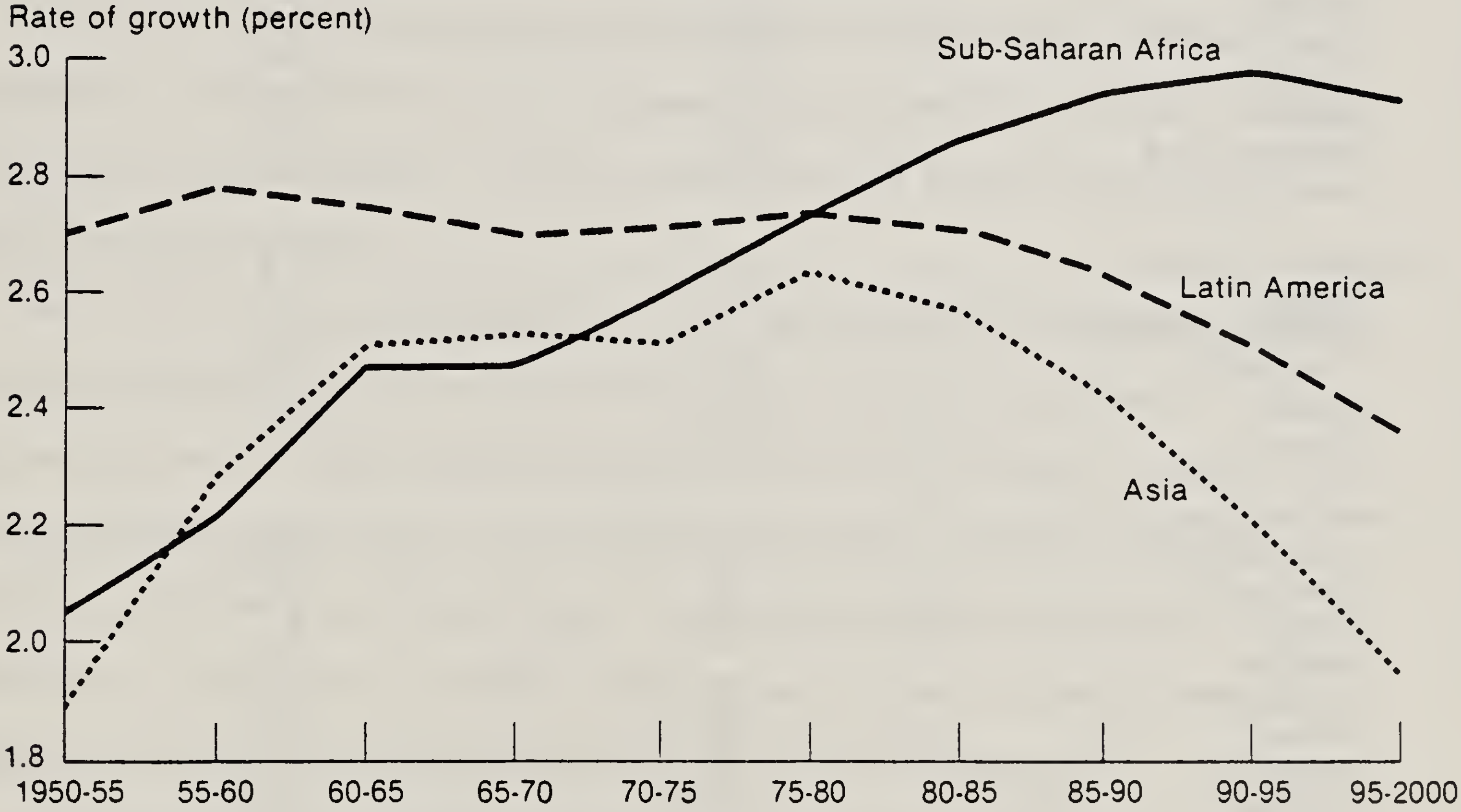
Sub-Saharan Africa is presently the least urbanized region in the world, with less than a quarter of its people living in cities. 19/ The urbanization rate, however, is high. Urban population growth rates of 5 percent or more per year are common (table 4). With an annual growth rate of 5 percent, the urban population will double within 14 years.

Urbanization puts a premium on convenience foods such as bread, rice, and processed foods which are often difficult to supply from local agricultural resources. Few Sub-Saharan countries can produce wheat in any significant quantities. Rice production is frequently high cost--both in relation to world market prices and in comparison with the cost of producing other staples. Commercial processing of local foodstuffs is not well developed. Meeting the rapidly expanding urban demand for food from local resources will

Figure 4

Sub-Saharan Africa, Asia, Latin America

Population Growth Rates, 1950-2000



Source: United Nations, World Population Trends and Policies, Vol. I.

Table 4--Urbanization in selected countries, Sub-Saharan Africa

Country	Percentage of population in urban areas, 1980	Urban population growth rate, 1970-80
	Percent	
Sahel:		
Chad	18	6.7
Mali	20	5.5
Mauritania	23	8.6
Niger	13	6.8
Senegal	25	3.3
Upper Volta	9	4.1
West Africa:		
Benin	14	3.9
Cameroon	35	7.5
Ghana	36	5.2
Guinea	19	6.1
Ivory Coast	38	8.2
Liberia	33	5.6
Nigeria	20	4.9
Sierra Leone	25	5.6
Togo	17	5.6
Central Africa:		
Angola	21	5.8
Central African Republic	41	4.9
Congo	37	3.2
Zaire	34	7.2
East Africa:		
Burundi	2	2.6
Ethiopia	15	6.9
Kenya	14	6.8
Rwanda	4	5.9
Somalia	30	5.1
Sudan	25	6.8
Tanzania	12	8.3
Uganda	12	7.0
Southern Africa:		
Lesotho	5	7.8
Madagascar	18	5.2
Malawi	9	6.2
Mozambique	9	6.8
Zambia	38	5.4
Zimbabwe:	23	6.4

Source: World Bank, World Development Report, 1980.

require better procurement and marketing policies, improved infrastructure, greater attention to the processing and storing of local staples, and more active attempts to shape the tastes and preferences of urban consumers.

Part of the problem with food supply is readily apparent. Aggregate food production in Sub-Saharan Africa has grown very slowly--about 1.8 percent per year. This is below the aggregate growth rate for Asia or Latin America. Some countries actually recorded declines in aggregate production between 1961-5 and 1979. Productivity has also been low (fig. 5). African cereal yields are less than half those in Asia. Yields for pulses, as well as for roots and tubers, are about two-thirds of Asian yields.

Growth in food production has depended heavily on expanded area. Increases in cultivated area have frequently offset declining yields (table 5). In the Sahel, however, both area and yield have declined significantly during the last decade.

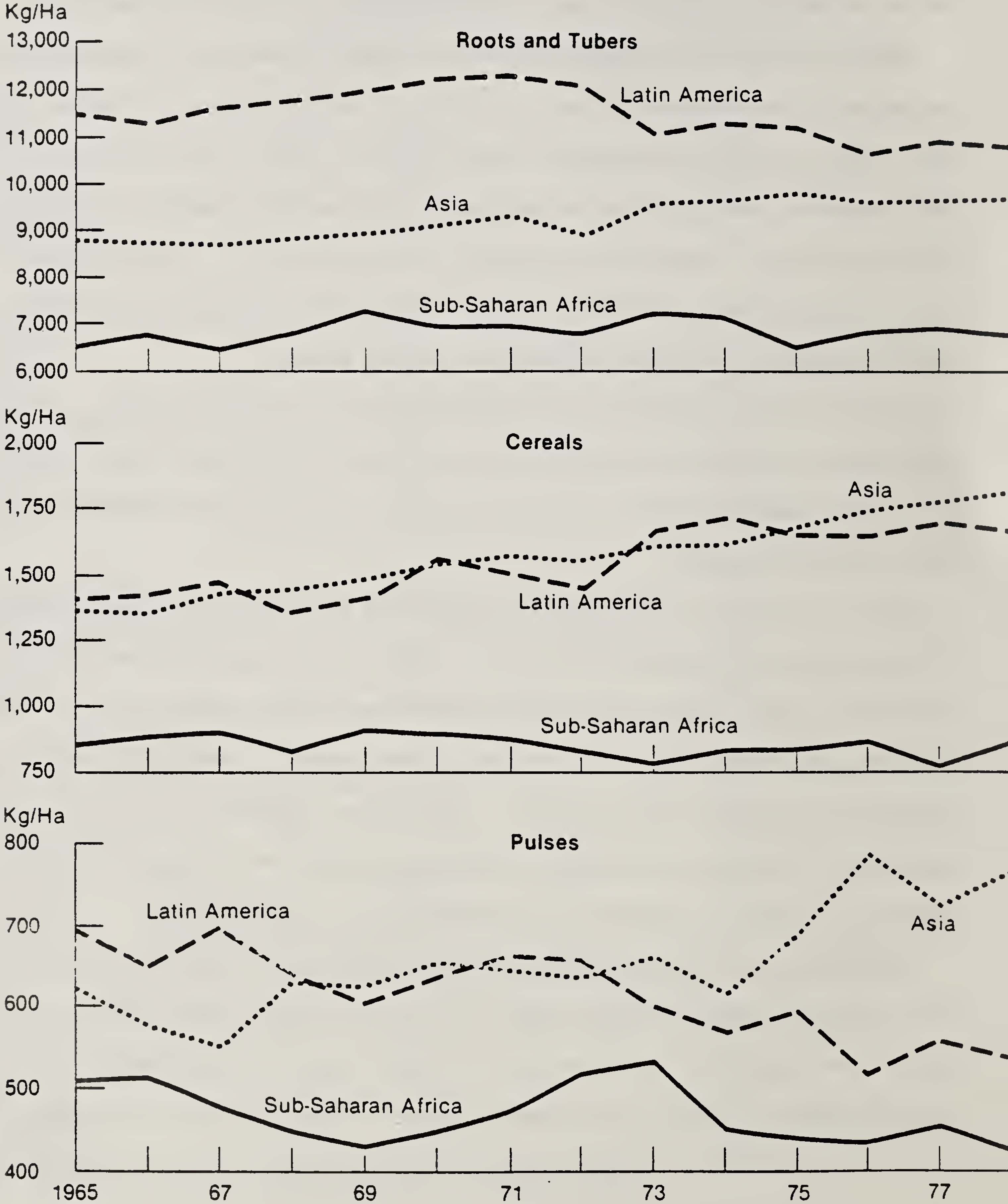
Part of the poor food production record can be explained by the structure of food production and the natural environment within which African cultivators work. While land tenure patterns vary from region to region, most food production takes place in the subsistence sector. Farmers generally cultivate relatively small holdings. Cultivation practices are land extensive. Rotation and elaborate cropping patterns are the major ways of managing the natural environment and maintaining soil fertility.

African agriculture in general and food production in particular make less use of modern commercial inputs than cultivation in any other region of the world. Fertilizer use is lower than in either Asia or Latin America. In addition, there is much less systematic water control. Africa has less than

Figure 5

Sub-Saharan Africa, Asia, and Latin America

Yields for Staple Crops



Source: Latin America and Asia-FAO Production Yearbook, Sub-Saharan Africa-ESCS estimates.

Table 5--Area, yield, and production: Average annual growth rates, Sub-Saharan Africa, 1962/64-1972/74

Commodity and region	Production	Yield	Area
		Percent	
Cereal:			
Sahel	-1.6	-1.3	-0.3
West Africa	.7	- .6	1.3
Central Africa	3.2	-1.6	4.7
East and Southern Africa	2.6	1.5	1.1
Roots and tubers:			
Sahel	- .7	-1.2	.5
West Africa	1.8	.4	1.4
Central Africa	1.4	-1.7	3.1
East and Southern Africa	1.7	3.3	-1.5
Pulses:			
Sahel	1.6	-1.9	3.5
West Africa	2.0	-2.6	4.8
Central Africa	1.9	-2.0	4.0
East and Southern Africa	1.9	- .2	2.1

Source: Food and Agriculture Organization, Regional Food Plan for Africa, July 1978.

one-twentieth the irrigated land (table 6) of Asia. The development of improved seeds and higher yielding varieties lags far behind accomplishments in other developing regions.

Basic foodstuffs are produced in large part by human labor, using simple hand tools like the hoe or the panga. The use of draft animals is more limited than in Asia, sometimes because of disease patterns, sometimes for cultural or economic reasons. 20/ Mechanization is used even less often. Africa has less than one-sixth the number of tractors in Asia, and only one-eighth the number in Latin America (table 6).

With little water control and few ways of dramatically increasing the amount of work which can be done in a short time, food production is vulnerable to changes in weather and variations in the timing of key seasonal activities. This vulnerability is reflected in large variations in yields and in total production.

Many of the cultivation practices developed by African food producers were sound adaptations to the natural environment. It would be an error to attribute lower levels of commercial inputs to the sheer backwardness of African food producers. The natural resource base in much of Africa is quite different from that in temperate climates. Soils are more fragile, and the need to protect them from direct exposure to sun and rain led to different styles of cultivation. Rainfall patterns determine the timing of soil preparation in areas where the ground is too hard to till until rain falls. The need to maintain fertility in delicate soils led to the perfection of complex rotation and fallow systems.

Nevertheless, these cultivation practices are beginning to reach their limits. The problem is not that land is, in general, scarce. On the

Table 6--Modern input use, Africa, Asia, and South America, 1977

Area	Percentage of irrigated land	Tractors per 10,000 hectares	Fertilizer used per hectare
	Percent	Number	Kilograms
Africa	1.8	7	4.4
Asia	28.0	45	45.4
South America	6.1	57	38.8

Source: Food and Agriculture Organization, Production Yearbook, and Fertilizer Yearbook, 1978.

contrary, Africa has more arable and permanent cropland than any other developing region--about 0.5 hectares per person (table 7). The situation is more complex however. First, population is not evenly distributed. Where there are major concentration of people--as along the coast in West Africa or in the East African highlands--there is local population pressure (fig. 6). Second, and more important, land in many areas is becoming scarce relative to the requirements of land extensive cultivation methods. Pressure on these systems affects the natural environment. Shorter fallow periods which degrade soil quality over time and the excessive use of marginal land are two examples of such pressure.

Over the decade of the 1980s, there will be a growing need to make a transition from land extensive cultivation performed with hand tools to cultivation which can use appropriate inputs to enhance soil fertility and increase the efficiency of labor. Unless viable means of producing food this way can be found, increases in productivity cannot be achieved. However, without a wider move toward more commercialized food production, supported by marketing infrastructure and policy. Even if productivity in the food sector in Sub-Saharan Africa rises by any imaginable degree, increased domestic demand cannot be satisfied.

Inadequate food production cannot be attributed solely to the food production sector, however. Two other factors loom large: the context within which food production occurs, and the policies which influence food production and distribution.

Food production occurs within a context shaped by the colonial experience. It is possible to explain some of the techniques used to produce

Table 7 --Cropland per person in Sub-Saharan Africa by region and country 1/

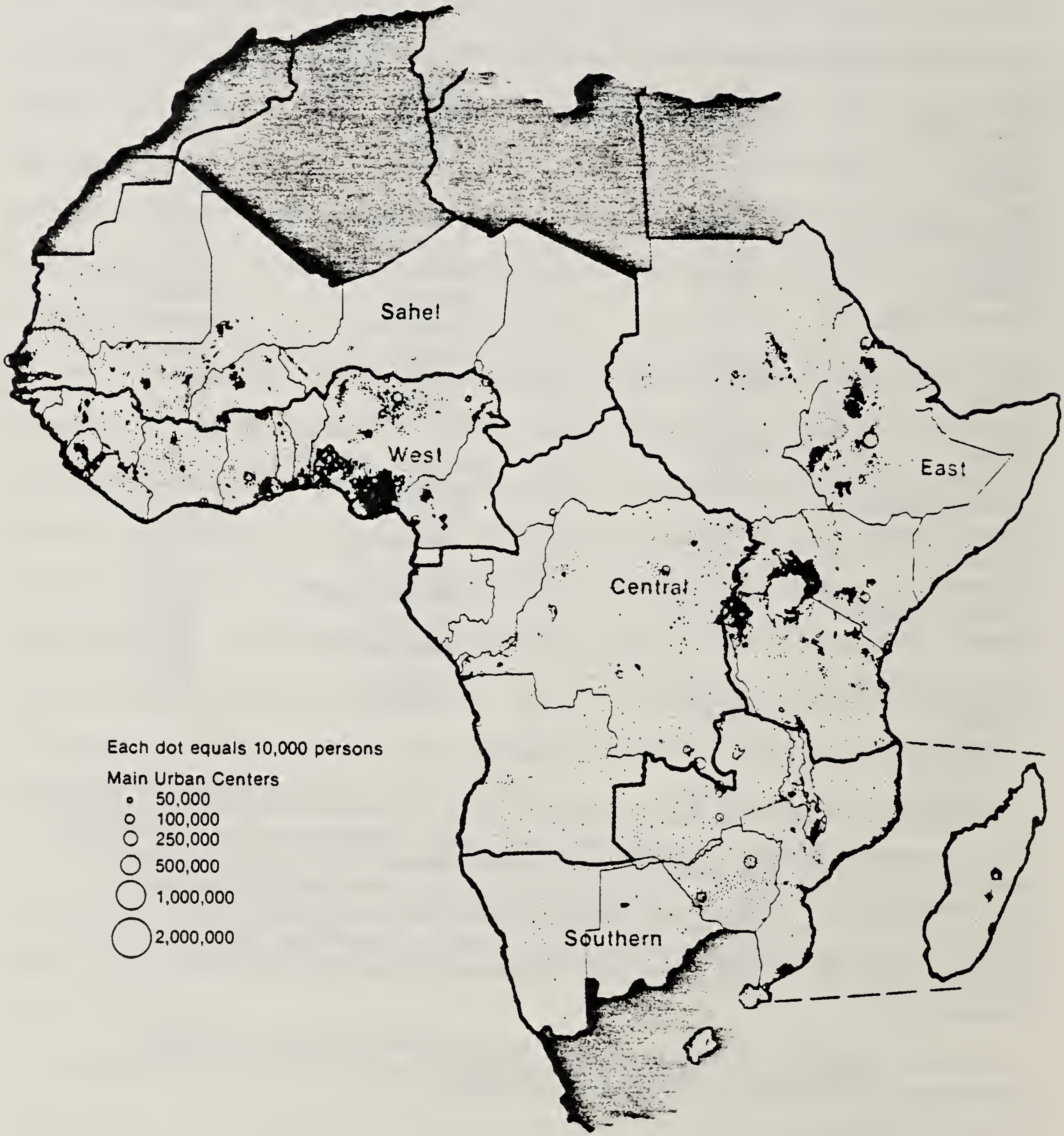
Region and country	Number of persons per km² cropland	Region and country	Number of persons per km² cropland
Sahel:	69.6	Congo	212.3
Cape Verde	750.0	Gabon	125.1
Chad	60.0	Zaire	417.5
Gambia	200.0		
Mali	61.1	East Africa:	275.5
Mauritania	682.7	Burundi	311.6
Niger	31.6	Ethiopia	213.6
Senegal	192.8	Kenya	623.9
Upper Volta	112.5	Rwanda	464.7
		Somalia	312.5
West Africa:	182.9	Sudan	259.6
Benin	110.1	Tanzania	321.1
Cameroon	90.3	Uganda	217.7
Ghana	386.9		
Guinea	111.3	Southern Africa:	208.5
Guinea-Bissau	315.8	Botswana	536.8
Ivory Coast	56.2	Lesotho	338.0
Liberia	483.8	Madagascar	276.5
Nigeria	277.5	Malawi	226.5
Sierra Leone	76.4	Mozambique	314.1
Togo	104.1	Namibia	152.8
		Swaziland	297.0
Central Africa:	241.7	Zambia	107.3
Angola	364.4	Zimbabwe	271.3
Central African Republic	31.7		

1/ Cropland refers to land defined by the FAO as arable land and land under permanent crops. It includes land under temporary crops, temporary meadows for mowing and pasture, land under market and kitchen gardens, land temporarily fallow or idle, and land cultivated with crops that ocupy the land for long periods and need not be replanted, such as rubber, cocoa and coffee. Definitions used by reporting countries vary, however, so that classification of different kinds of land may be inconsistent.

Source: Economics, Statistics, and Cooperatives Service; and Food Agriculture Organizaton, Production Yearbook, 1978.

Figure 6

Population Distribution in Sub-Saharan Africa



food by understanding the natural environment. It is not possible to understand the social and economic relations which govern food production or the trade in foodstuffs without some reference to the history of Sub-Saharan Africa.

The structure of African agriculture has been heavily shaped by policies designed to integrate colonies into metropolitan trading networks, and sometimes, to protect settler populations. Taxation policy was instrumental in stimulating the production of agricultural exports (West Africa) as well as in providing a labor force for mining or plantation production (Southern and Central Africa) or working on settler-operated farms (Eastern and Southern Africa). 21/ Concessions to European settlers and investors profoundly affected land tenure systems in Eastern, Southern and Central Africa. 22/ Trade patterns, and the interests of European settlers, shaped the development of infrastructure and commercial relations, agricultural technology, market access, and the direction of agricultural research. 23/

While there were major regional differences, several common themes emerged. African food production became a primarily subsistence activity, even in areas where substantial trade in foodstuffs existed before colonialism. Second, male participation in the off-farm work force or in cash crop cultivation frequently made women more responsible for food production. Third, lack of colonial interest in African food production meant little sustained research on food production, and hence, a relatively poor understanding of African production processes. Recommendations for change were frequently counter-productive. 24/ Research on export crops was more extensive, and generally more productive.

While the historical dimensions of African food production are complex, three general patterns can be discerned. 25/ Throughout much of West Africa, the development of export-oriented agriculture was the mainstay of the colonial trade economy. The region had neither known deposits of minerals or settler colonization. Policies were therefore directed at creating tropical agricultural exports, produced by African farmers themselves. Costs of production were kept low enough to eliminate substitutes being developed within European markets. 26/ The coastal areas were linked directly with external markets, while the hinterland served as a pool of labor for the coast. In areas where land and labor were abundant, the initial cultivation of export crops did not come at the expense of food crop production. 27/ Food crops were grown for domestic consumption along with commercial export crops. Africans were frequently entrepreneurial-cultivators--using "traditional" ties to increase export crop production. 28/ In other areas, however, introducing exports crops dislocated subsistence food production. 29/ The marketing of export crops here as in other regions was generally handled by non-Africans, while the virtual equation of cash and export crops limited the commercialization of food marketing.

In Central Africa, the production of agricultural export crops was generally managed by European concessionary companies. Industrial plantations for producing export crops were established directly by European investors, and worked by coerced or cheap labor. The African role in the commercial, export crop was thus more limited. African food production remained a subsistence activity, and no commercial market for domestic foodstuffs developed.

In Eastern and Southern Africa, colonial policy toward the agricultural sector was shaped by two forces: the labor requirements of mining and the presence of large settler populations. A major thrust of colonial policy was to create labor reserves, both for mining and for working settler operated farms. 30/ The need to feed miners--often migrants from distant areas--created the potential for a commercial market in foodstuffs. Initially this market was served by African producers. 31/ However, restrictions on land ownership and porduction reduced the role of African producers. Commercial procurement came primarily from larger white owned farms whose market position was supported by a wide range of government policies. 32/ The result was a dual land tenure system which had a major, negative impact on African food production.

Africa`s historical legacy affects food production today. The trade patterns shaped by colonialism have not been fundamentally changed. Few countries have been able to significantly diversify their exports, or move away from primary exports to more highly processed goods. As a result, many governments` agricultural policies have supported the export activities which dominated their economies at independence, and now provided much of their foreign exchange and tax revenue. Furthermore, reflecting historical conceptions about subsistence production, African governments have given food production relatively low priority. Finally, the historical legacy is clearly apparent in the lack of infrastructure for effectively procuring and marketing locally produced foodstuffs.

History is not the only relevant contextual factor, however. Political turmoil since independence has significantly reduced both food production and

the ability to create internal commercial markets. Internal conflict motivates cultivators in a number of countries to move further away from roads, and to minimize their contact with outsiders. Intra-state conflicts have created refugee populations which, in turn, become a burden on the food production systems in the countries which house them. Repressive internal regimes have created new incentives to return to subsistence cultivation in some countries. In all cases, political turmoil disrupts the delivery of inputs, and makes sustained increases in productivity difficult to achieve.

Finally, it is important to examine the socio-economic features of rural areas themselves. Goods and services found in urban areas are often not available in rural areas. Higher prices for agricultural products will not stimulate more production if the consumer goods which people want to buy are unavailable. In addition, more personal income will often not enable rural residents to purchase important services, since the infrastructure needed to provide them is ot present, and cannot be financed through individual expenditures. Such services include hospitals, schools, safe drinking water, electricity, and decent roads. The net effect is to make even the good life which might be achieved in rural areas no comparison with life in urban areas.

Neither does the education system place much emphasis on agriculture. Information and skills which might improve agricultural practices are not taught. The general orientation of education suggests that farming is not a job for educated people. Hence, upward mobility is associated with high status non agricultural jobs, often in urban areas.

The general rural conditions, coupled with the physical drudgery of farming and the dominant orientation of educational systems have several

consequences. First, younger, more ambitious people migrate from rural areas leaving agriculture to older, less educated people. In some countries, such migration is now creating a shortage of rural labor. Second, farming is not considered a career, and lacks prestige. Third, incentives to invest in improving food production are absent or misdirected. Money made in agriculture is often invested in other activities--ranging from education designed to assure that some family member can move out of agriculture to the purchase of small shops or a stock of goods for petty trading.

Government policy has also contributed to the poor food production record in Sub-Saharan Africa. While virtually all governments intervene in the production and marketing of food, agricultural policy in general and food policy in particular tend to be derived policy. The intended beneficiaries of the policies are groups other than the producers themselves. 33/ The dominant thrust of most food policies, at least until the early seventies was to keep domestic food prices low. In large part, these policies were designed to benefit urban consumers. 34/ Hence, farm prices were often set at low levels, which discouraged farmers from marketing more food through official channels and reduced the incentive to invest in making food production a commercial enterprise. Trade policies were oriented toward supplying urban consumers with cheap food, not with supporting farm income or attempting to build a strong internal marketing for domestically produced food (as is the case in many industrial countries). While government-controlled marketing institutions were designed in some cases to eliminate the unsavory actions of middlemen, they also had a strong interest in controlling procurement while keeping costs down. Compulsory procurement requirements and attempts by some

governments to operate state farms were shaped by the need to procure for the urban market. 35/

Policies oriented toward increasing food production and productivity would have required additional objectives, and different policy instruments. These include promoting change in agricultural practices by building effective rural institutions and adequate transportation and marketing networks and providing appropriate social and economic incentives for their use through supportive price, credit and input policies.

In the aftermath of the food crisis of the early seventies, most African countries are attempting to become self-sufficient in key food crops. The interest has been reflected in the rhetoric and content of national plans, as well as in international forums. The African members of FAO requested an assessment of what would be required to achieve food self-sufficiency by 1990. 36/ The first Organization for African Unity (OAU) economic summit held in May 1980, placed increased food self-sufficiency high on its agenda. 37/ Many countries have responded positively to offers from FAO and the International Food Council to arrange for assistance with studies of their agricultural sector. 38/ Nevertheless, performance in the agricultural sector to date has lagged behind the rhetoric.

Improving food production will require more than organizing new production campaigns or removing past disincentives to production such as low producer prices. A whole range of policies--governing pricing, procurement, trade, storage, inputs, credit and investment--interact in important ways. If there are major inconsistencies among key aspects of these policies, the effect of one "correct" policy may be overshadowed by the impact of other policies, or

the constraints on policy implementation generated by the conflicting policies themselves.

One of the key objectives of our analysis, therefore, will be to make clear the major forces influencing the current food balance, and the interactions among policies, production practices, and the environment which shape the prospects for improved production over the next decade.

CONCEPTUAL FRAMEWORK

The study analyzes the supply and demand for several of the most basic African foods: wheat, rice, millet, sorghum, maize, pulses, and roots, tubers and plantains (RTP). 39/ While meat, dairy products and fish are important foods, they will be omitted for two reasons. First, despite local variations in diet, the bulk of the calories in all Subsaharan countries come from grains, pulses, and RTP. These will be the commodities whose production and consumption will most directly affect on diets during the next decade. Second, a detailed analysis of the livestock and fish production sectors would have required more time and resources than were available.

Five subregions within Sub-Saharan Africa are examined: the Sahel, West Africa, East Africa, Central Africa, and Southern Africa (excluding South Africa). In figure 7, countries are grouped by subregion as defined in the present study. The emphasis on subregions flows from two considerations. First, highly aggregated results for Africa as a whole often mask important differences among countries and localities. 40/ Second, national studies are time consuming, and require aggregation if the "big picture" is to emerge. The subregional focus is, therefore, an attempt to introduce enough detail to capture major variations, and suggests themes for future studies.

Figure 7

Sub-Saharan Africa

Any regionalization is somewhat arbitrary. Three points were considered in creating the subregions. First, the subregions should attempt to reflect major differences in historical experience. Second, they should permit as much comparability as possible between this study and others addressing similar issues. Third, using subregional classifications helps to explore the impacts that one country`s policies may have on its neighbors.

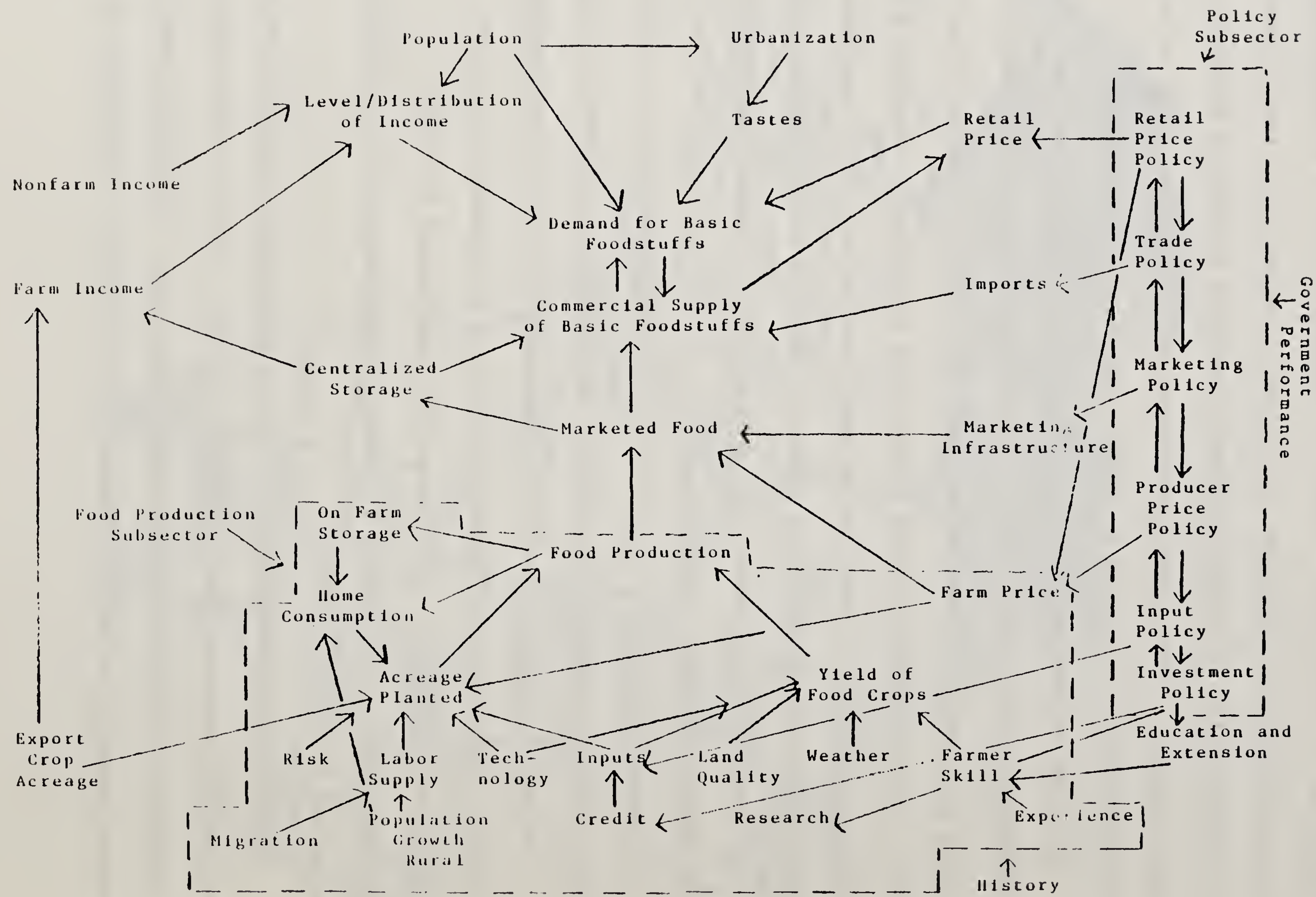
The study focuses explicitly on food crop production, and does not deal systematically with export crops. This choice reflects both a certain realism about what could be accomplished within the time frame of the research effort, and an attempt to focus attention on a relatively neglected aspect of African agriculture. There are certain costs to this focus, however. The study can say nothing about the possible tradeoffs between increased emphasis on food production and export crop production. This is an important issue which may be explored in later studies.

A summary of the major factors affecting the food balance in Sub-Saharan Africa, and the principal interactions among them, is presented in figure 3.

The demand for basic foodstuffs depends on the size of the population, level and distribution of income, tastes, and the retail price of the commodities considered. Urbanization is hypothesized to affect tastes--primarily in creating a preference for foods which are faster and more convenient to prepare.

The interaction between demand and the commercial supply of food affects, but does not determine the retail price of food. This is because many African governments attempt to control retail food prices. It affects them, however, because uncontrolled markets exist in most countries. Governments may attempt

Figure 8--Interaction among food balance factors, Sub-Saharan Africa



to control retail prices in several ways. Historically, low retail prices depended on a willingness to import if doing so meant lower costs. When world market prices soared however, most governments did not have the financial resources to insulate consumers from higher prices, and rising import prices forced increases in retail prices.

A low retail price may also be supported by forcing some other sector of society to subsidize urban consumers. A low farm price shifts the burden to rural areas. Over the long term however, domestic procurement will be difficult and imports and/or unofficial markets become more important. If low cost imports are unavailable, a consumer subsidy must be paid from general government revenue, squeezed from the farmer by compulsory procurement, or eliminated.

The commercial food supply depends on domestic production levels, the share of production which is marketed, the quantity of food imported, and the drawdown (or buildup) of stocks.

Most food production takes place within the subsistence sector. This means that the primary purpose for growing food is to feed the cultivators themselves. Some portion of what is grown may be marketed, but it is not enough to make marketing the reason for producing. Given this orientation, farmers may respond to conditions in the marketplace, but will not permit those conditions to color the whole food production process. This situation is quite different from that in which export crops are produced, even when the same people and the same physical location are involved. The reason for growing export crops is to sell them, while the reason for growing food crops is to eat them.

Having a large share of food produced in the subsistence sector creates some special marketing and supply problems. In a bad year, the quantity of food marketed is likely to drop by much more than the shortfall in production. Producers will meet their own food needs first, leaving little or nothing to market. An exceptionally good year may dramatically increase marketing, since farmers are not likely to eat all that much more, and they have a relatively limited capacity for storing more than they need to provide a reasonable measure of food security for themselves. In general, then, there will be greater fluctuations in marketed food than in production itself.

Uncertainty about the reliability of subsistence producers` marketings, may be as serious a problem for governments as the more frequently discussed cost of reaching many small producers or the logistics of servicing them. Conversely, whether subsistence farmers make an effort to market depends on the price they receive for their product and the reliability of the marketing system itself. Remunerative prices, combined with an adequate marketing system, can create an incentive for regular marketing; often, one of these is lacking.

Whether farmers can in fact produce enough to market regularly depends on the level of production they can actually achieve. Food production depends on the acreage planted to food crops and the yield obtained. Planted acreage is limited by how much can be physically cultivated given the land available, the labor supply, and the technology and inputs used. How much is planted depends on home consumption needs (for the subsistence farmer), an assessment of the risk involved, and the price farmers except to receive for what they sell.

Crop yields depend on the land quality, weather, the skill of the farmer, and the technology and inputs used. For most subsistence farmers, skill

depends primarily on experience, individual and communal. Education and effective extension can enhance farmers` skill, as well as introduce them to new technologies and inputs. Whether these are used, however, depends both on how much yields increase, and whether it is economically practical to adopt them.

What is economically possible depends heavily on government policy, as well as upon what is economically efficient. Marketing policy, producer price policy, input policy and investment policy all influence food production. Some of the effects are direct, others are mediated by the interactions among policies themselves. Whether policies are implemented effectively depends ultimately on the performance and skill of those who must carry them out.

ORGANIZATION

The paper has three central objectives. The first is to describe and analyze the major forces affecting the food balance, as they are portrayed in figure 8. The structure of the demand for food, as well as the policies which shape it, are analyzed in Chapter II. The non-economic factors shaping food production are analyzed in Chapter III, while the policies affecting it are detailed in Chapter IV.

The second objective is to make quantitative projections of the food balance in Sub-Saharan Africa in 1990, taking into account as many of the factors which affect it as possible. The model developed to do this, the results of the estimation process, and the relationship between our results and those of other studies are presented in Chapter V. In addition to projecting what is likely to happen if present trends continue, the model can

be used to explore hypothetical scenarios. Scenarios can be used to explore alternative production situations, as well as the impact of government policies and changing economic conditions. The scenarios, and their implications, are also presented in Chapter V.

The final objective is to draw conclusions about the food problems and prospects of Sub-Saharan Africa, and to relate those conclusions to changes which might be undertaken during the next decade. Our conclusions are presented in Chapter VI.

FOOTNOTES

1/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Indices of Agricultural Production in Africa and the Near East, SB-637, June 1980.

2/ Calorie intake by itself is not an adequate measure of nutritional well-being. An adequate supply of basic vitamins and minerals should be included. The special protein needs of pregnant and lactating women and children under age 2 need to be taken into account. Finally, populations plaqued with parasites may have higher requirements for key nutrients.

3/ United Nations, Preliminary Assessment of the World Food Situation, Present and Future, (Rome, 1974).

4/ Shlomo Reutlinger and Marcelo Selowsky, Malnutrition and Poverty (Baltimore: Johns Hopkins Press, 1976).

5/ This has led IFPRI to measure the calorie gap by the difference between the food supply and 110% of minimal calorie requirements. Food Needs of Developing Countries: Projections of Production and Consumption to 1990, (Washington, D.C.: IFPRI, December 1977).

6/ U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, World Analysis Branch, "Foreign Exchange and International Price Developments," No. 3, (March 1980).

7/ For discussion of the changing political economy of food, see Raymond Hopkins and Don Puchala, The Political Economy of Food, (Madison, Wisconsin: University of Wisconsin Press, 1979).

8/ For a discussion of the changing structure of U.S. agriculture, see U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Structural Issues of American Agriculture, AER-438, November, 1979.

9/ For a discussion of the difficulties in devising economic policies to cope with the consequences of rising, and unstable, prices, see John Duplop and Kenneth Fedon (eds.), The Lessons of Wage and Price Controls--The Food Sector, (Cambridge, Mass.: Harvard University Press, 1977).

10/ For a discussion of the role that subjective uncertainty plays in determining the comparative advantages of developing countries, see Cathy Jabara and Robert Thompson, "Agricultural Comparative Advantage Under International Price Uncertainty: The Case of Senegal," American Journal of Agricultural Economics, Vol. 62, No. 2, May 1980.

11/ For a discussion of the gasahol issue, see Ronald Meekhof, Mohinder Gill, and Wallace Tyner, Gasohol: Prospects and Duplications, USDA, ESCS, AER-458, June 1980.

12/ IFPRI, Food Needs of Developing Countries, (Washington, D.C.: IFPRI, December 1977).

13/ FAO, Regional Food Plan for Africa, ARC/7815 (Rome: June 1978).

14/ In the case Sub-Saharan Africa, where there is a large subsistence sector, this calculation may overstate nutritional inadequacies if home consumption is omitted from measures of demand.

15/ IRPRI, Food Needs of Developing Countries, Washington, D.C.: IFPRI, December 1977); FAO, Regional Food Plan for Africa, ARC/1815 (Rome: June 1978).

16/ While West African diets rise above minimal levels, the calorie gap in the Sahel is 1.4 million tons, Central Africa 0.6, and East Africa 8.1.

17/ IFPRI, Food Needs of Developing Countries, Washington, D.C.: IFPRI December 1977).

18/ United Nations, World Population Trends and Policies: 1977 Monitoring Report, (New York; UN, 1979).

19/ United Nations, World Population Trends and Polices: 1977 Monitoring Report, (New York: UN, 1979).

20/ For a review of some of the factors affecting theuse of animal cultivation, see Chris Delgado and John McIntire, "Economic Constraints on Farming with Plow Oxen in the Sahel," mimeographed, (July 1980).

21/ For a discussion of the use of tax policy to force selective participation in the commercial economy, see E.S. Brett, Colonialization and Underdevelopment in East Africa, (London: Heinemann, 1973); Robert Rotberg and Ali Mazrui (eds.), Power and Protest in Africa, Oxford, England: Oxford Univ. Press. 1970).

22/ See Brett, Colonalization and Underdevelopment in East Africa, Colin Leys, Underdevelopment in Kenya, (London: Heinemann, 1975) and the essays in Robin Palmer and Neil Parson (eds.), The Roots of Rural Poverty in Central and Southern Africa, (Berkley: University of California Press, 1977).

23/ See Robin Palmer, "The Agricultural History of Rhodesia"; Jean-Luc Vellut, "Rural Poverty in Western Shaba c 1890-1930"; Bogumil Jewsiewicki, "Unequal Development: Capitalism and the Kutanga Economy, 1919-40"; and Maul Muntemisa, "Thwarted Development: A Case Study of Economic Change in Kabwe Rural District of Zambia 1902-70" in Palmer and Parsons, The Roots of Rural Poverty in Central and Southern Africa, (Berkley: University of California Press, 1977), Brett, Colonialization and Underdevelopment in East Africa.

24/ See R. Bates, who identifies this as a major issue on the "rural agenda" of Africa.

25/ The distinction is based on Samir Amin, "Underdevelopment and Dependence in Black Africa-Origins and Contemporary Forms" in Janet Abu-Lughol and Richard Haye jr., Third World Urbanization (Chicago: Maaroufa Press, 1977), pp. 140-150.

26/ Amin, "Underdevelopment and Dependence in Black Africa - Origins and Contemporary Forms".

27/ For examples of cocoa production in partsof Chana and Nigeria, see Polly Hill, The Migrant Cocoa Farmers of Southern Ghana, Cambridge, Mass: Cambridge University Press, 1963) and Sava Berry, Cocoa, Custom and Socio-Economic Change in Rural Western Nigeria (Clarendon: Oxford University Press. 1975).

28/ Hill, The Migrant Cocoa Farmers of Southern Ghana; Berry, Cocoa, Custom and Socio-Economic Change in Rural Western Nigeria.

29/ For examples, see Jean Cabot and Christian Bouguet, Le Tchad (Paris: Presses Universities de France, 1973), pp. 83-4.

30/ Amin, "Underdevelopment and Dependence in Black Africa - Origins and Contemporary Forms" and Palmer and Parsons, The Roots of Rural Poverty in Central and Southern Africa.

31/ Palmer and Parsons, The Roots of Rural Poverty in Central and Southern Africa.

32/ Palmer and Parsons, The Roots of Rural Poverty in Central and Southern Africa.

33/ Robert Bates, Political Economy of Agricultural Policy in Africa (tentative title, draft manuscript, 1979).

34/ For more of a discussion of the urban bias, see Michael Lipton Why, the Poor Stay Poor? Urban Bias in World Development, (Cambridge, Mass: Harvard University Press, 1977)

35/ This has been a general theme not only in Africa but in societies such as the USSR and China, where procurement heavily influenced the organization of agricultural production.

36/ See the FAO Regional Food Plan.

37/ See West Africa, No. 3278 (May 19, 1980), pp. 870-71 and No. 3279 (May 26, 1980), for discussion of the OAU Plan of Action.

38/ Some countries in Africa have to date reported assistance in preparing these studies.

39/ Pulses include: dried beans, dried peas, and lentils. Roots, tubers andplantains include: cassava, yams, cocoyams, sweet potatoes, white potatoes, bananas and plantains.

40/ This was the case for a variety of studies we attempted to analyze, including Wassily Leontief andothers, The Future of the World Economy, (Oxford, England: Oxford University Press, 1977) and Mihajlo Mesanovic and Edward Pestel, Mankind at the Turning Point: The Second Report to the Club of Rome, (New York: Dutton, 1964).

CHAPTER II. FOOD DEMAND IN SUB-SAHARAN AFRICA

THE STRUCTURE OF DEMAND

The diets of Sub-Saharan Africa are dominated by the consumption of roots, tubers, and cereals (table 8). In virtually every country, these items in some combination provide more than 50 percent of daily calorie consumption. In the Sahel, diets are heavily cereal based. In the more humid regions of West Africa, roots and tubers are important, sometimes overshadowing cereals. Some Central African countries such as Zaire have diets heavily based on cassava, with cereal consumption primarily in cities. Even in countries with relatively high concentrations of nomadic people (for example, Somalia) or important cattle operations (for example, Botswana), the bulk of the national diet is still derived from cereals and/or roots and tubers.

There are clear urban-rural differences in diet. Wheat as a complementary food (in the form of bread) and rice as a staple, are becoming increasingly important in urban areas, often displacing the traditional food.

Consumption patterns are determined by supply and demand. A country's aggregate demand for food commodities is affected by many variables, including the price of the commodity, the growth and structure of population, income levels, and tastes and preferences. The geographic distribution of the population, income distribution, the distribution of tastes and preferences and the coincidence and interaction of these variables also affect demand. For example, urbanization has a major impact on demand. This may be a result of the interaction and coincidence of higher income in urban areas as well as changing tastes and preferences for different foods resulting from rural-urban migration.

Table 8--Calories from cereals, roots, tubers and plantains, Sub-Saharan Africa

Country	Percentage of daily per capita caloric intake from: (daily average 1972-74)		
	Cereal	Roots, tubers and plantains	Total
		Percent	
Sahel:			
Cape Verde	56.3	7.0	63.3
Chad	66.0	3.4	69.4
Gambia	63.5	1.8	65.3
Mali	76.0	1.9	77.9
Mauritania	55.2	-	55.2
Niger	70.0	-	70.0
Senegal	62.6	3.9	66.5
Upper Volta	73.7	2.5	76.2
West Africa:			
Benin	41.6	32.0	76.3
Cameroon	36.6	31.4	68.0
Ghana	28.8	45.3	74.1
Guinea	59.1	20.9	80.0
Guinea-Bissau	50.5	19.4	69.9
Ivory Coast	35.7	40.6	76.3
Liberia	45.9	32.3	78.2
Nigeria	41.4	36.8	78.2
Sierra Leone	56.0	15.5	71.5
Togo	42.7	36.5	79.2
Central Africa:			
Angola	32.0	37.2	69.2
Central African Republic	22.9	52.9	75.8
Congo	12.6	65.7	78.3
Gabon	6.4	67.9	74.3
Zaire	16.1	60.8	76.9
East Africa.			
Burundi	26.5	43.6	70.1
Ethiopia	70.6	3.0	73.0
Kenya	57.3	11.6	68.9
Rwanda 1/	18.5	56.5	75.0
Somalia	55.0	2.1	57.1
Sudan	47.3	10.6	57.9
Tanzania	33.9	30.3	64.2
Uganda 2/	29.8	31.5	61.3
Southern Africa:			
Botswana	59.6	-	59.6
Lesotho	53.2	-	53.2
Madagascar	64.4	16.6	81.0
Malawi	76.2	1.9	78.1
Mozambique	35.3	38.9	74.15
Namibia	46.1	14.4	60.5
Swaziland	58.1	2.3	60.4
Zambia	67.9	5.5	73.4
Zimbabwe	67.8	5.0	73.28

- = Value less than one percent
1/ Plaintains make up 30% of caloric intake.
2/ Plaintains make up 15% of caloric intake.
Source: Food and Agriculture Organization, Provisional Food Balance Sheets, 1972-74 Average.

Population

Total population and the rate of population growth affect the demand for food. Africa`s rate of population growth increased steadily over the last twenty years from 2.05 percent in the mid-fifties to 2.74 percent in the late seventies. Africa now has the highest population growth rate of any developing area. 1/

Population growth rates will continue to be high over the next decade. Indeed, Africa is the only developing region where population growth rates will continue to increase throughout the 1980s. Growth rates will be higher than those experienced historically and are not expected to level of until about 1990, when they will be about 3 percent per year (table 9). East, West, and Southern Africa will have countries with population growth in excess of 3 percent a year. In East Africa, these countries include Kenya, Rwanda, Tanzania, Uganda, and Sudan. In West Africa, Ghana and Nigeria will experience these high growth rates. In Southern Africa, Namibia, Zambia, and Zimbabwe will have high growth rates, Zimbabwe with a rate of 3.6 percent per year.

Attempts to slow population growth will have relatively little impact on the demand for food during the 1980s. Most of the growth in food demand projected for the next decade comes from the structure of the present population. Africa has not even entered the first stage of the demographic transition where death rates decline. Both crude birth rates and death rates are high--the highest of any region in the world. Since a decline in death rates generally precedes a fall in birth rates, a decline in population growth during the 1980s is extremely unlikely. The age structure also works against

Table 9--Population growth rates, Sub-Saharan Africa

Region and country	1970-75	1985-90	Region and country	1970-75	1985-90
	Percent			Percent	
Sahel:			Central Africa--Con.		
Chad	2.00	2.16	Congo	2.44	2.84
Gambia	1.92	2.13	Equatorial Guinea	1.71	1.96
Mali	2.42	2.74	Gabon	1.00	.90
Mauritania	1.99	2.35	Zaire	2.47	2.85
Niger	2.68	2.97			
Senegal	2.37	2.55	East Africa:		
Upper Volta	2.27	2.49	Burundi	2.60	2.72
			Ethiopia	2.39	2.60
West Africa:			Kenya	3.38	3.45
Benin	2.70	2.80	Rwanda	3.04	3.14
Cameroon	1.84	2.45	Somalia	2.65	3.00
Ghana	2.70	3.19	Sudan	2.56	2.94
Guinea	2.38	2.68	Tanzania	3.02	3.20
Guinea-Bissau	1.51	1.94	Uganda	2.93	3.09
Ivory Coast	2.51	2.79			
Liberia	2.29	2.57	Southern Africa:		
Nigeria	2.67	3.09	Botswana	2.27	2.99
Sierra Leone	2.41	2.65	Lesotho	1.92	2.32
Togo	2.74	2.49	Malawi	2.52	2.74
			Mozambique	2.32	2.64
Central Africa:			Namibia	2.84	3.07
Angola	2.27	2.73	Swaziland	2.73	2.92
Central African			Zambia	3.13	3.38
Republic	2.09	2.59	Zimbabwe	3.35	3.60

Source: United Nations, World Population Trends and Policies 1977 Monitoring Report.

a significant short-term reduction in population growth. African populations are young, often with as many as 40 percent of their people under 15 years of age. The number of people in their reproductive prime will, therefore, grow during the next decade, while the prospect for reducing population growth will remain minimal.

Tastes and Preferences

Peoples` tastes and preferences for various foods differ; that is, with the same income and the same set of food prices, people will eat different things. Urbanization may be one variable which has an impact on what people prefer to eat. Work patterns change and time becomes more valuable. People want food which takes less time to prepare, such as wheat and rice.

Preferences may also change because of exposure to new kinds of food. Food aid is at least partially responsible for developing tastes for wheat and rice.

Income

Growth in income, and particularly the distribution of income are determining factors in the structure of demand. People in lower income groups spend a larger percentage of their income on food and buy less costly food. Therefore, growth policies which favor the top 20 percent of the population produce a different structure of commercial demand than growth which is egalitarian or targeted toward the lower income groups. In turn, these patterns of demand have an impact on the profitability of various commodities and thus help determine which producers will benefit the most.

Income elasticities by income groups would give better predictive capacity than the aggregate figures which are generally used. Unfortunately there is very little information on income distribution in Africa and even less on

consumption patterns by income groups. Table 10 gives an idea of the patchiness of the available data on income distribution. Yet some generalizations can be made: 1) In most countries, the top 20 percent of the population has more than half the income. 2) The bottom 40 percent generally has less than 20 percent of the income. 3) Given the low per capita income of many African countries, the middle 40 percent do not constitute a middle class in the Western sense of the term. Indeed, absolute poverty may extend well into the middle 40 percent.

The income elasticities from our model have been estimated using regional data on aggregate income and food consumption (table 11). No attempt has been made to use any information on income distribution.

Using the income elasticities and other information the following statements can be made about future demand in Africa. 1) The income elasticities of demand for wheat and rice are generally high. This is largely due to changing tastes and preferences in urban areas and the relative luxury status of wheat and rice. 2) The movement away from direct cereal consumption--characteristic of many developed countries--is not imminent in Africa. Most cereals have positive income elasticities in most regions. Third roots and tubers and millet and sorghum have a negative income elasticity in some areas. However this is not universal. Income growth, particularly of the bottom 40 percent, may generate demand for these products. Attempts to increase this group's production may be viable even if income increases. Last as in most other countries with high carbohydrate diets, protein foods such as eggs, milk, fish, and meat have high income elasticities. Income growth, particularly to the top 20 percent, will

Table 10 -- Income distribution for selected countries, Sub-Saharan Africa

Country	Survey Year	Cover- age	Popula- tion	Income share of lowest 40%	Income share of: middle 40%	Income share of top 20%
					Percent	
Benin	1959	NL	1/ POP	15.0	32.5	51.7
Botswana	1971-2	NL	EAP	7.6	32.1	60.3
Chad	1958	NL	POP	19.3	35.9	44.8
Gabon	1968	NL	IR	8.5	24.0	67.5
Kenya	1959	NL	IR	11.7	35.7	52.6
Madgascar	1970	NL	POP	13.0	26.9	60.1
Malawi	1969	NL	HH	15.0	32.1	62.9
Senegal	1960	NL	POP	9.4	28.1	62.5
Sierra Leone	1968-9	NL	2/ HH	7.2	30.0	62.8
Sudan	1963	3/ UR	HH	13.9	36.0	50.1
Tanzania	1969	NL	HH	7.8	28.9	63.3
Uganda	1970	NL	4/	16.6	36.6	46.6
Zambia	1959	NL	HH	13.0	28.8	58.6
Zimbabwe	1968	NL	IR	8.1	22.7	69.2

NL=National; UR=Urban; POP=Total population; EAP=Economically active; HH=Household; IR=Income Recipient

1/ Total population is not a well defined term. For example, in some instances it corresponds to individuals ranked by per capita household income. Household income refers to income earned by a household without reflecting household size and per capita income. The economically active population refers to the labor force, both employed and unemployed. Income recipient refers to individuals receiving income of any kind, including transfer payments.

2/ Does not include the Western province.

3/ Omdurman, urban.

4/ African male employees.

Source: Shail Jain, Size Distribution of Income. Washington, D.C. World Bank, 1975. This publication includes sources for each survey, pp. 123-37.

Table 11 --Income elasticities by region, Sub-Saharan Africa

Region	Wheat	Rice	Corn	Millet	Sorghum	Roots and: tubers	Pulses
Sahel	0.92	0 .93	0.46	0.15	1/	-0.04	-0.14
West	.87	.65	.14	.09	1/	.12	.42
Central	.55	.93	.66	.28	1/	-.14	-.21
East	.51	.58	.28	.01	.18	.29	-.02
Southern	1.46	.56	.34	.17	1/	-.15	-.002

1/ Combined with millet.

stimulate a transition to diets which require greater human and agricultural resources (transition to grainfed livestock). 2/ In such a growth pattern, basic foodstuffs like coarse grains and cassava will be more profitably employed as livestock feed. Some of demand for the livestock feed may be external.

Prices

Price elasticities of demand indicate the responsiveness of consumer purchases to price changes. The lower the elasticity, the larger the change in consumption from a price change. Consumer demand for wheat and rice is found in our model to be very responsive to price changes, indicating the relative luxury status of these particular commodities and also their responsiveness to price policy manipulation (table 12). Millet and maize are generally less responsive to price changes, indicating a lack of substitutes for these products as well as their role as staple foods.

UNMET NUTRITIONAL NEEDS

Estimates of aggregate unmet nutritional needs differ. However, both the FAO per capita approach and the World Bank`s distribution-sensitive analysis agree that there has been no real progress in reducing aggregate nutritional

Table 12--Price elasticities of demand for major food commodities by region, Sub-Saharan Africa 1/

Region	Wheat	Rice	Maize	Millet	Sorghum
Sahel	-.30	-.35	N	-.60	2/
West Africa	-.15	-.53	N	.50	2/
Central Africa	N	-.52	-.38	-.22	2/
East Africa	-.55	-.34	N	-.03	-.11
Southern Africa	-.55	-.15	N	N	N

N = Not included, based on economic reasoning.
1/ No prices were available for roots, tubers or pulses.
2/ Combined with millet.

shortfalls over the last decade. FAO finds African per capita energy supplies for 1976 only 5 percent above the 1961-65 level, and still about 10 percent below minimal requirements. The World Bank finds the malnourished portion of the population to be nearly constant--while the number of underfed people grew by 40 million. 3/

The "calorie gap" between current consumption standards and minimal calorie requirements is large. In 1965, the World Bank estimated the African calorie deficit as 10 percent of total calorie consumption and 19 percent of total cereal consumption. Meeting this deficit by imported cereals at an assumed retail price of $200 per metric ton would have cost 3.9 percent of GNP.

In some parts of the world, undernutrition is primarily a distribution problem. This is, in general, not true for Africa; inadequate nutrition is both a production and a distribution problem. 4/ Aggregate supplies are

inadequate--even assuming totally equalitarian distribution. Furthermore, much of the inequality in income which exists reflects urban-rural differences.

Poverty-linked malnutrition is prevalent among several clearly identifiable groups. These groups are the smaller or marginal subsistence farmer, the nomadic herdsman, the urban poor, and the landless rural laborer. Most of Africa's poverty is the poverty of small or marginal subsistence farmers. They have access to some land, but are vulnerable to weather shifts, changes in the natural resource base, and seasonal food shortages. Productivity is generally low. Several droughts can mean starvation, or the need for massive food relief.

Several African countries have sizable nomadic populations. These people tend to be poor even by national standards. They are very vulnerable to severe weather changes, and to degradation of the natural resource base. Massive food relief, when needed, may be extremely expensive--or impossible--to deliver.

While Africa's low level of urbanization has meant the urban poor are a relatively small part of the total population, urban poverty is nonetheless pervasive. More than half the population of many major cities live in slums or "unplanned" neighborhoods. 5/ Generally these people are unable to find adequate employment in the mainstream urban economy.

As in Asia, the rural landless are frequently the most impoverished group. In Africa, there are few landless laborers, reflecting both the relative availability of land and traditional communal land tenure systems.

countries, composite flours using local products such as millet, sorghum and cassava are being tried. 7/ Senegal is commercially marketing bread composed of 30 percent millet and 70 percent wheat flour. Similar attempts on a trial basis are being made in Nigeria and Sudan. Tanzania has experimented with a 10 percent sorghum, 90 percent wheat flour, and has marketed a pure sorghum flour. Plans for manufacturing cassava flour are being evaluated. 8/

Consumption can also be regulated through controls on the supply of a commodity. In a situation where retail prices are not controlled, the manipulation of the quantity available on the market affects consumption not only by limiting the amount available, but also by affecting the price. Allowing imports or restricting exports of a good will tend to depress prices. Encouraging exports and restricting imports will tend to cause the price to rise. The same effects occur if the government releases stored grain or buys up grain.

Import restrictions to control the quantity of wheat and rice available have been used to limit urban consumption of these commodities. Quantitative restrictions on imports of these commodities were put into effect in Nigeria, although relaxation of such restrictions was necessitated by strong urban demand in the face of limited domestic supply. In Liberia, attempts were made to contain consumer demand for rice through import restrictions and price increases. These measures sparked the severe "rice riots" of April 1979 and led the Government to keep prices and imports unchanged. The political repurcussions of these measures cannot be underestimated.

Sahel

Consumption Patterns

Millet and sorghum are the basic food grains consumed in the Sahel. These are supplemented by varying amounts of maize, rice and cassava. Most of these foodstuffs are produced for subsistence and consumed on the farm while small amounts are traded at the local level and marketed in deficit areas. For four of the Sahelian countries, the annual per capita consumption of millet and sorghum ranges from 140 kg. to 240 kg. 9/ In Cape Verde, maize is the staple food. In the Gambia and Senegal, rice figures importantly. In the latter two countries, domestically produced rice is almost totally consumed in the regions of production since it is easier and more economical to supply the cities with a cheaper broken rice imported from Asia. In any case, domestic production only satisfies one-third, and one-fourth of domestic demand in the Gambia and Senegal, respectively.

Urban consumers have more disposable income than rural inhabitants which allows them to purchase a greater variety of food items including imported items. Millet and sorghum become a less important part of daily consumption in favor of rice which despite its high price compared to coarse grains is preferred for its taste and short time of preparation. In rural areas, the diet tends to be less varied due to the dependence on a few locally grown staples such as millet and sorghum. In the Gambia, Senegal and to a lesser extent Mali, rural consumption of rice in areas of production is also significant. In the former, about 30 percent of imported rice is consumed in rural areas. Wheat is also an important element in the urban diet, mainly in the form of bread, and, as with rice, is very important as a convenience food

Table 14--Selected data on food consumption, Sahel.

Country	Staple foods 1/ Rural	Staple foods 1/ Urban	Average annual cereals imports, 1976-78 2/	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 3/
	--Food items--		1,000 metric tons	Percent
Cape Verde	Maize	Maize	NA	77
Chad	Millet, sorghum	Rice, wheat	14.2	76
Gambia	Rice	Rice	40.9	101
Mali	Millet, rice sorghum	Rice, wheat	30.8	76
Mauritania	Millet, sorghum	Rice, wheat	122.0	81
Niger	Millet, sorghum	Rice, wheat	23.4	85
Senegal	Millet, rice	Rice, wheat	137.4	108
Upper Volta	Millet, sorghum	Rice, wheat	39.0	71

NA = Not available.

1/ Economics, Statistics and Cooperatives Service.

2/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets." Cereals refers to wheat, rice, corn, barley and oats.

3/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment 1979, Table II-3.

(table 14). Urban consumption of these two items is primarily satisfied through imports.

It is unclear the extent to which current (and likely future) consumer tastes are supportive of the countries' food self-sufficiency objectives. Wheat production is virtually nonexistent and rice production both costly and inadequate to meet demand. There is little consumer substitutability between millet and rice or between imported rice and domestic rice. For these reasons it is likely that imports of wheat and rice will play an important role in the diets of the urban population.

Retail Policies

Price Controls: Official consumer prices for basic goods have been strictly controlled, with the essential aim of keeping salaries low (table 15). These controls apply to domestically produced and marketed commodities as well as to imports. In practice, price policies have been more consumer-biased since the former group is generally more vocal than producers and wields more political power. There are some signs that these biases are changing. Producer prices have been increased and, at least in Senegal, retail prices for rice and other foodstuffs were raised substantially. However, retail price and import policies affecting rice and wheat are likely to remain politically sensitive.

The agency responsible for price setting in Senegal does not set a consumer price for millet and sorghum. It appears that price fluctuations can be mitigated through the manipulation of imported rice supplies. When there is an upward pressure on millet and sorghum prices, the official marketing agency can release greater quantities of rice to release this pressure. In

Table 15--Retail price controls for locally produced and imported food crops, Sahel

Country and major foods consumed	Has retail price control
Cape Verde	
Millet & sorghum	
Maize	
Chad	
Rice	X
Wheat 1/	X
Millet & sorghum	X
Maize	
Gambia	
Rice	X
Millet & sorghum	-
Maize	-
Mali	
Wheat 2/	X
Rice	X
Millet & sorghum	X
Maize	X
Mauritania	
Rice	X
Millet & sorghum	X
Maize	X
Niger	
Wheat 2/	-
Rice	X
Millet & sorghum	X
Maize	X
Senegal	
Wheat 2/	X
Rice	X
Millet & sorghum	-
Maize	-
Upper Volta	
Wheat 2/	
Rice	X
Millet & sorghum	X
Maize	X

X = Retail price control in effect.
- = No retail control in effect or no information available.
1/ Mostly imported but some local production.
2/ Imports only.

Mali, for political reasons, the Government intends to lower consumer prices for basic foodstuffs.

As most of the farmers consume what they produce and trade locally at unofficial prices, retail price controls are targeted primarily to the urban consumer. However, due to financial and administrative constraints, most government agencies have been unable to enforce consumer prices and ensure supply. An extensive parallel market exists where prices are often three times those in the official market. In the Bamako market, for example, there is currently a very high unofficial consumer price for millet and sorghum which has attracted substantial grain flows from neighboring Upper Volta. The lower controlled price usually benefits only certain privileged groups.

Other Retail-Level Policies: In addition to efforts aimed at increasing the supply of domestic rice, the Government of Senegal is attempting to reduce per capita demand for rice and wheat in favor of increased consumption of local cereals. Bakers are required to use a composite flour with up to 30 percent millet flour. Similarly, an instant couscous (a traditional cereal-based dish) is being experimented with to encourage millet consumption.

West Africa

Consumption Patterns

Since most foodstuffs are consumed and traded locally, consumption in West Africa of these crops primarily reflects regional differences in local production patterns. In Benin, Cameroon, Ghana, the Ivory Coast, Nigeria, and Togo, coarse grains such as millet and sorghum predominate in the northern regions, while roots and tubers are most widely consumed in the South. Yams and maize are also important consumption items in certain areas. In the other countries rice is the staple supplemented by cassava (table 16).

Table 16--Selected data on food consumption, West Africa.

Country	Staple foods 1/		Average annual cereals imports, 1976-78 2/	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 3/
	Rural	Urban		
	--Food items--		1,000 metric tons	Percent
Benin	Maize, millet	Rice, wheat	41.3	94
Cameroon	Maize, millet	Maize, millet	104.6	101
Ghana	Maize, cassava	Maize, cassava wheat	211.9	84
Guinea	Rice, cassava	Rice	54.8	83
Guinea-Bissau	Rice, cassava	Rice, cassava	NA	100
Ivory Coast	Cassava, millet	Cassava, rice, wheat	243.3	116
Liberia	Rice	Rice, cassava	61.3	97
Nigeria	Rice, maize, sorghum	Rice, cassava, wheat	925.0	86
Sierra Leone	Rice	Rice, wheat	37.7	97
Togo	Rice, maize, millet, cassava	Rice, wheat, cassava	NA	95

NA = Not available.
1/ Economics, Statistics and Cooperatives Service.
2/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets." Cereals refers to wheat, rice, corn, barley and oats.
3/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment 1979, Table II-3.

There are significant differences between urban and rural consumption patterns throughout West Africa . Rice and wheat are becoming the most important elements in the urban diet at the expense of traditional crops. Both commodities are preferred for their taste and their short preparation time.

Since for most countries in the region, urban consumption is primarily met through imports, increasing urbanization has obvious implications which may not be compatible with food self-sufficiency objectives. Production of wheat is virtually non-existent, while production of rice is constrained by deficiences in marketing and in pricing policies. Neither is there direct substitutability between imported and domestic rice. Currently in most countries, there is a clear consumer preference for imported rice. While import controls for rice can provide an incentive to domestic production, significant retail price increases and/or restrictions in amounts available can have serious repercussions in urban areas.

Retail Policies

All West African the countries have some form of retail price controls which help to maintain stable urban consumer prices (table 17). Controls on foodstuffs are not generally effective and prices tend to be determined by supply and demand factors. Isolation of markets, market inefficiencies (including inefficient transportation and storage facilities), seasonal shortages and increasing demand have fueled rapid price increases in recent years.

Rice and wheat (bread) 10/ are the primary food items whose retail prices the governments attempt to control. Prices of other foodstuffs are generally

Table 17--Retail price controls for locally produced and imported food crops, West Africa

Country and major foods consumed	Has retail price control
Benin	
Rice	X
Wheat 1/	-
Millet and sorghum	X
Maize	X
Roots and tubers	X
Cameroon	
Rice	X
Wheat 1/	-
Millet and sorghum	X
Maize	X
Roots and tubers	X
Ghana	
Rice	-
Wheat 1/	X
Millet and sorghum	X
Maize	X
Roots and tubers	X
Guinea	
Rice	-
Wheat 1/	X
Millet and sorghum	X
Maize	-
Roots and tubers	-
Guinea-Bissau	
Rice	-
Wheat 1/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-
Ivory Coast	
Rice	-
Wheat 1/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-

Table 17--Retail price controls for locally produced and imported food crops, West Africa (continued)

Country and major foods consumed	Has retail price control
Liberia	
Rice	X
Wheat 1/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-
Niger	
Rice	X
Wheat 2/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-
Sierra Leone	
Rice	X
Wheat 1/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-
Togo	
Rice	-
Wheat 1/	-
Millet and sorghum	-
Maize	-
Roots and tubers	-

X = Retail price controls in effect.
- = No retail price controls in effect or no information.
1/ Imports only.
2/ Mostly imported but some local production.

not controlled. There is a continuing tension in most countries between maintaining retail prices at a certain level and providing incentives to producers through increased farm-gate prices. Efforts to achieve self-sufficiency in rice for example, could lead to import restrictions and higher retail prices but political realities often dictate against the enforcement of such actions.

In most countries, the retail price of rice, although set low relative to domestic costs of production, allows sizeable profits for importers since it is higher than the world price. Imported rice is generally sold at the same retail price as domestic rice.

In Ghana, the prices of basic foodstuffs have soared and the interim Government attempted to control retail prices through the flogging of traders and jail sentences for those selling above the controlled prices. These measures created a strong disincentive for farmers to bring their produce to the market and supplies dropped drastically. It is not clear how these problems will be resolved.

Retail prices in Cameroon and Benin are forced higher by increased demand from Nigeria. Both countries have nominal price controls which are generally unenforceable, and thus retail prices are effectively determined by market forces.

Central Africa

Consumption Patterns

Roots and tubers are the major source of calories in central Africa. Their contribution to total caloric intake ranges from 30 percent in Angola to 60 percent in Congo and Zaire. Cassava is by far the most important tuber in

the entire region. Besides the tuber, the leaves of the cassava plant supply about 20 percent of the dietary protein. Maize like cassava is produced everywhere in the region, but it is second to cassava except in southern Zaire and central Angola where maize meal is the staple food. Bananas and plantains supply a significant number of calories, especially in Gabon and the Central African Republic. Millet and sorghum enter into the food balance only in southern Angola and in the Central African Republic (table 18).

In the cities, bread has become established as a convenience food for breakfast and snacks because it preserves better than cassava chips (chick wanga) and because its price has been more stable. In Kinshasa, bread is not consumed at the principal meal where either cassava meal (fufu), maize meal, or rice are served as the main course. The average monthly consumption of food per family in Kinshasa in 1973 (based on a survey of 1,471 familes) included mainly 36 kilograms of cassava, 10 kilograms of bread, 9 kilograms of cassava leaves, 5 kilograms of bananas, 4 kilograms of rice, and 2 kilograms of beans. When devaluation of the zaire early in 1980 raised the price of bread by 60 percent relative to domestically produced cassava, bread consumption dropped by 25 percent in Kinshasa. Tastes and preferences have been strongly influenced by those of the colonizing nations. In Gabon those who can afford it (and many can) eat the same foods as well-to-do Parisians. Bread is a part of this colonial heritage that even the less rich urban dwellers in all the countries can afford. The high income consumers in all the countries demand imported meat and dairy products.

Rice, though not an important staple in Central Africa in the past,has now gained popularity in the cities. Most of this rice is imported, although Zaire and Angola produce a part of their needs.

Table 18--Selected data on food consumption, Central Africa.

Country	Staple foods 1/ Rural	Staple foods 1/ Urban	Average annual cereals imports, 1976-78 2/	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 3/
	--Food items--		1,000 metric tons	Percent
Angola	Cassava, maize	Cassava, wheat	153.7	69
Central African Republic	Sorghum, maize cassava	Wheat, rice	11.5	98
Congo	Cassava, rice maize	Wheat, rice	60.8	95
Gabon	Cassava, plantains	Wheat, rice	27.6	NA
Zaire	Cassava, maize wheat	Cassava, maize wheat	381.6	83

NA = not available.
1/ Economics, Statistics and Cooperatives Service.
2/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets." Cereals refers to wheat, rice, corn, barley and oats.
3/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment 1979, Table II-3.

Beyond this are deeply ingrained preferences that developed in each area. For example white maize is the preferred staple in Angola and southern Zaire. Plantains and bananas are an important part of the diet in Gabon, but not in Angola.

Retail Policies

Retail prices are controlled in all the countries of Central Africa, but the controls are often not effective (see table 19). The agricultural attaché wrote from Zaire in 1978, "In Kinshasa, prevailing retail prices are almost double those decreed." Many other reports attest to the failure of retail price controls, especially in the smaller markets where government monitors rarely set foot. Luanda (Angola) papers have carried stories about high prices paid on the black market to evade price control and rationing. Some foods are more successfully controlled than others. For example bread prices, all fixed by the central African countries, are difficult to circumvent because of the small number of bakeries. Retail price control has been only partially successful.

Table 19--Retail price controls for locally produced and imported food crops, Central Africa

Country and major foods consumed	Has retail price control
Angola	
Rice 1/	X
Wheat 2/	X
Millet and sorghum	-
Maize	X
Roots and tubers	X
Central African Republic	
Wheat 2/	-
Millet and sorghum	X
Maize	X
Roots and tubers	X
Congo	
Wheat 2/	X
Maize	X
Roots and tubers	X
Gabon	
Wheat 2/	X
Rice 1/	X
Roots and tubers	X
Zaire	
Rice 1/	X
Wheat 2/	X
Millet and sorghum	X
Maize	X
Roots and tubers	X

X = Retail price controls in effect.
- = No retail price controls in effect or no information available.
1/ Mostly imported but some local production.
2/ Imports only.

East Africa

Consumption Patterns

A variety of foods are consumed in East Africa (table 20). The composition of the diets differs among countries and even within regions of the countries themselves. In most cases, the major sources of calories are cereals and root crops; in a few places, pulses and plantains are also important. Kenya's consumption of milk and dairy products is higher than average for Africa because of a fairly successful dairy sector. Consumption of animal products is significant among pastoralists in some parts of the region, particularly in Somalia; over two-thirds of its population are pastoralists. Grain is consumed among these groups more as a relief measure during drought than as a normal habit.

The staple food in Kenya and Tanzania is maize, which is consumed in both rural and urban areas. Recently, per capita consumption of maize has apparently been increasing, possibly due to relative shortages of other grains. Maize is an important food in every other East African country except the Sudan. Cassava, millet, and sorghum are also important rural foods in Kenya and Tanzania. Rice is both a subsistence rural crop in parts of Tanzania and a preferred urban food. It is not significant in the rest of the region. Sorghum is the main staple of Somalia and Sudan. Wheat is consumed in sizeable quantities in Kenya, Sudan, and Ethiopia, and to a lesser degree in Tanzania. Wheat consumption is primarily an urban phenomenon in these countries, except for Ethiopia where it is a traditional crop.

For half the countries in the region, there are a number of staples. In countries with smaller urban sectors there is little distinction between urban and rural diets. Rwanda, Burundi, and southern Uganda are well watered areas

Table 20--Selected data on food consumption, East Africa.

Country	Staple foods 1/		Average annual cereal imports, 1976-78 2/	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 3/
	Rural	Urban		
	-- Food items --		1,000 metric tons	Percent
Burundi	Maize, sweet potatoes cassava, plantains, pulses	Cassava, sweet potatoes, pulses, plantains	30.5	106
Ethiopia	Teff, maize, barley sorghum, wheat	Teff, maize, barley sorghum, wheat	70.3	69
Kenya	Maize	Wheat, maize	43.1	96
Rwanda	Plantains, pulses, maize, sweet potatoes	Plantains, pulses sweet potatoes	6.5	82
Somalia	Maize, sorghum	Maize	73.9	77
Sudan	Sorghum, wheat	Sorghum, wheat	88.8	93
Tanzania	Maize, rice, cassava	Wheat, maize, rice	108.1	81
Uganda	Plantains, pulses millet, maize, sweet potatoes cassava	Plantains, pulses, millet, maize, sweet potatoes	15.3	80

NA = not available.
1/ Economics, Statistics and Cooperatives Service.
2/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets." Cereals refers to wheat, rice, corn, barley and oats.
3/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment, 1979, Table II-3.

supporting a diverse crop mix. Bananas or plantains, beans, cassava, maize, and sweet potatoes are all common foods. The situation in Ethiopia is unique. In addition to maize and sorghum, wheat, barley, and tef, another small grain related to wheat, are the main foods.

Retail Policies

Price Controls--Price controls exist in Kenya, Tanzania, Sudan, and Somalia and are most effective in urban areas (see table 21). Free or "black" market prices for food are often much higher than official prices in Tanzania and Kenya. The extent of control in Ethiopia is limited, but supply controls (for example grain imports) have been used to depress urban prices. Ugandan food prices have skyrocketed as the marketing system has deteriorated. Neither Rwanda nor Burundi have large retail networks nor effective controls.

Pressure to keep consumer prices low is a real constraint in East Africa. In 1979, steep increases in the prices of basic commodities in Sudan, including flour and sugar, led to strikes and riots in some urban areas. Urban pressure is a key factor in Tanzania and Kenya which have large demands for preferred grains. Imports of grain are subsidized for consumers in Somalia, Sudan, Kenya, and Tanzania.

Other Retail-Level Controls--Exhortations by various governments have not reduced the trend toward greater wheat consumption in Sudan, Kenya, and Tanzania, nor rice in Tanzania. In the latter country, consumers have not demonstrated interest in purchasing millet, sorghum, or cassava, which the Government has tried to encourage. Although not a traditional food in any East African country except Ethiopia, wheat is gaining popularity for reasons of convenience and taste. In Kenya, the government has effectively checked rice consumption by severely restricting imports. However, in Tanzania,

Table 21:--Retail price controls for locally produced and imported food crops, East Africa

Country and major foods consumed	Has official retail price controls
Burundi	
Roots and tubers	-
Maize	-
Pulses	-
Ethiopia	
Teff	-
Maize	-
Barley	-
Wheat	-
Sorghum	-
Kenya	
Rice 1/	X
Wheat	X
Millet and sorghum	-
Maize	X
Roots and tubers	-
Rwanda	
Roots and tubers	-
Maize	-
Pulses	-
Somalia	
Sorghum	X
Maize	X
Sudan	
Wheat	X
Sorghum	X
Tanzania	
Rice	X
Wheat	X
Millet and sorghum	-
Maize	X
Roots and tubers	-
Uganda	
Millet	X
Maize	X
Roots and tubers	

X = Retail price controls in effect.
- = No retail price controls in effect or no information available.
1/ Mostly imported but some local production.

growing urban demand for rice is somewhat of a problem. Imports provide much of the urban supplies. Maize consumption is subsidized.

Unlike other parts of Africa, where urban dwellers sometimes shun traditional foods, maize remains popular in East African towns and cities. One reason for this is probably the convenience of maize preparation which differs from that of other traditional foods such as yams.

Southern Africa

Consumption patterns

Maize is the dominant food of Southern Africa in both urban and rural areas. The major variations from this pattern are as follows: cassava is the predominant food for much of rural Mozambique; sorghum consumption is very high in Botswana; mahangu, a type of barley, is the leading food in rural Namibia; wheat is important in Lesotho and has been for many years but it is still second to maize. Rice is also consumed in the region but is still only a minor crop except in Madagascar where per capita rice consumption is among the highest in the world (table 22).

The position of wheat in Southern Africa is interesting. This crop has been grown successfully in Lesotho because of suitable conditions such as high altitude. The popularity of this food is probably due to Lesotho's proximity and close ties to South Africa. In Zambia, wheat consumption is increasing rapidly despite the fact that it is a completely foreign crop. Small trials are underway to adapt the crop to Zambian conditions, but domestic production is only about 5 percent of the country's present consumption. Bread is a popular food in most of Zambia but distribution of wheat flour is limited outside the urban areas. On the other hand, Zimbabwe had managed to reach

Table 22--Selected data on food consumption, Southern Africa.

Country	Staple foods 1/		Average annual cereals imports, 1976-78 2/	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 3/
	Rural	Urban		
	--Food items--		1,000 metric tons	Percent
Botswana	Maize, sorghum	Maize	4/ 39.5	73
Lesotho	Maize, wheat	Maize, wheat	63.3	95
Madagascar	Rice	Rice	174.6	107
Malawi	Maize	Maize	40.2	93
Mozambique	Cassava, maize, wheat rice	Cassava, wheat, rice	192.0	73
Namibia	Mahangu	Maize	NA	95
Swaziland	Maize	Maize	4/ 13.0	94
Zambia	Maize	Maize	61.8	95
Zimbabwe	Maize	Maize	30.3	109

NA = Not available.
1/ Economics, Statistics and Cooperatives Service.
2/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets." Cereals refers to wheat, rice, corn, barley and oats.
3/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment 1979, Table II-3.
4/ 1976-77 data.

self-sufficiency in wheat by the late seventies and actually had an overproduction problem. However, per capita consumption is relatively low despite a large urban and nonfarm population in Zimbabwe. Much of the wheat is consumed by the Europeans in the country. Mozambique has recently been importing greater amounts of wheat. This increase may partially reflect the availability of imported grains. Mozambique's main supplier, South Africa, is unable to supply white maize at present, and yellow maize is being imported. As a result there may be more interest in wheat.

Nutritional levels are less than satisfactory in most of the region. Cereals and/or root crops provide the greatest number of calories. The most frequent food shortages appear to occur in Lesotho. In spite of the food aid which has been received, many people are isolated by the rugged terrain. Low per capita calorie levels are also a problem in Botswana, Swaziland, Zambia, and Mozambique. Zimbabwe has a fairly high calorie level; the diet contains more beef, dairy products and sugar than is average for Africa. However, this pattern is far from uniform and there are considerable differences which reflect income inequities. Calorie levels in Malawi are also relatively high, but mostly maize is consumed.

Retail Policies

The majority of the countries in the region control prices for cereal crops (see table 23). Zambia has recently started to raise consumer prices by reducing subsidies. Because of strong urban pressures, this has been resisted for some time. Widespread shortages of essential consumer goods are common and this is a sensitive issue. Although the Government wanted to drop subsidies completely, the cost of imported maize was considered too much of a

Table 23: Retail price controls for locally produced and imported food crops, Southern Africa

Country and major food crops	Has official retail price controls
Botswana	
Sorghum	X
Maize	X
Lesotho	
Wheat	X
Sorghum	-
Maize	X
Madagascar	
Rice	X
Cassava	-
Malawi	
Rice	-
Maize	-
Cassava	-
Mozambique	
Rice	X
Maize	X
Cassava	-
Millet and sorghum	-
Namibia	
Maize	
Mahangu	
Swaziland	
Maize	-
Zambia	
Millet and sorghum	X
Maize	-
Cassava	-
Zimbabwe	
Wheat	X
Millet and sorghum	-
Maize	X
Cassava	

X = Retail price controls in effect.
- = No retail price controls in effect or no information available.

burden for low income groups without a subsidy. This may end when imports are no longer needed.

Just before the recent election in Zimbabwe, the interim government lowered consumer food prices in an attempt to gain support. Prices can probably be expected to rise somewhat but increases will probably be constrained due to rising expectations about the new government.

Rice consumption is subsidized in Madagascar; both local and imported rice prices are kept low.

FOOTNOTES

1/ U.N., World Population Trends and Policies 1977 Monitoring Report.

2/ See FAO food balance sheets, FAO, Agricultural Commodity Projections, 1970-1980, volume II, pp. 85-407.

3/ Shlomo Reutlinger and Marcelo Selowsky, Malnutrition and Poverty, (Baltimore, Johns Hopkins, 1976).

4/ See Cheryl Christensen, "The Right to Food: How to Guarantee," in Alternatives, A Journal of World Policy, (New York, Institute for World Order, 1978).

5/ UN, World Housing Survey, Report of the Secretary General, (New York, 1973)

6/ The seminal article on this subject is P. V. Sukhatme, "The Protein Problem: Its Size and Nature, Journal of Royal Statistical Society, 1974, vol. 137, p. 166.

7/ FAO, State of Food and Agriculture, (Rome 1978).

8/ Government of Tanzania, Marketing Development Bureau, Ministry of Agriculture, Surplus Sorghum, Millet and Cassava, Dar es Salaam, 1979.

9/ Ranging from 55 to 97 percent of total cereals consumption.

10/ Bread is not a staple like rice but it is an important complement to meals.

CHAPTER III. FOOD SUPPLY IN SUB-SAHARAN AFRICA

INTRODUCTION

Can food production, on the basis of the resources likely to be available to farmers and in the context of prevailing policies, possibly increase sufficiently to reverse the present downward trend in food production per capita in Sub-Saharan Africa? For this to happen, the resources devoted to food production will have to be utilized much more efficiently than at any time in the past, and policy decisions will have to be conducive to increasing farmer productivity. This chapter discusses the first of these matters, and Chapter IV, the second.

ENVIRONMENT AND RESOURCES

African Ecosystems

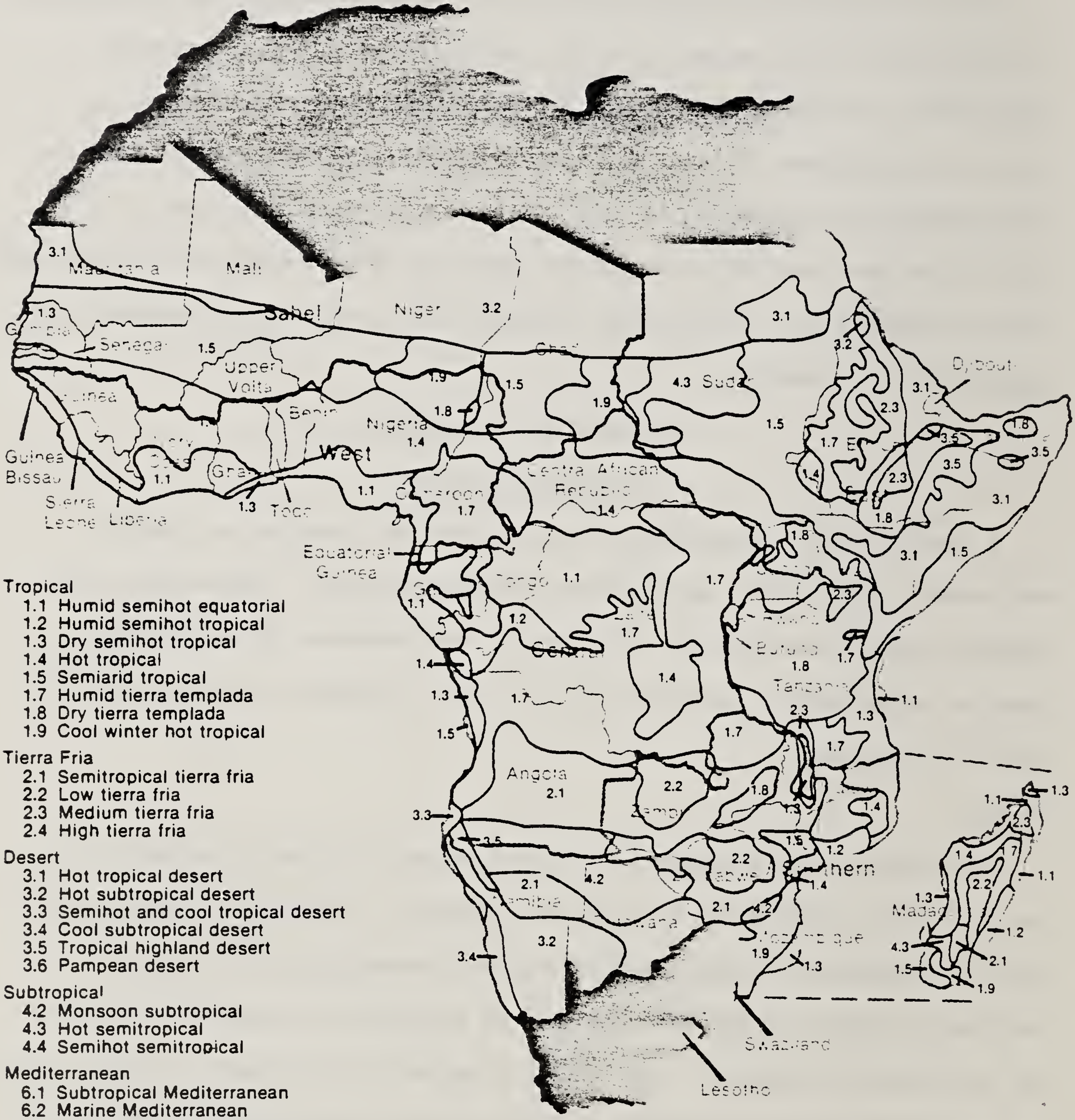
A combination of temperature, rainfall and soil creates the physical environment within which agricultural production occurs. Temperature and rainfall have the most direct influence on the character of ecosystems. Because temperature is generally high all year, rainfall essentially defines Africa`s ecosystems.

Climate

This report adopts Papadakis` classification of climatic regions 1/ to relate Africa`s ecosystems to production patterns. Papadakis` classification has the advantage of being based on critical temperatures of certain cultivated plants and the water balance of soils and is intended to be used for agricultural purposes. The climatic regions will be found in figure 9 and the accompanying key in Appendix A. The following describes the five regions of the present study in terms of Papadakis` climatic classification:

Figure 9

Climatic Regions



Tropical
- 1.1 Humid semihot equatorial
- 1.2 Humid semihot tropical
- 1.3 Dry semihot tropical
- 1.4 Hot tropical
- 1.5 Semiarid tropical
- 1.7 Humid tierra templada
- 1.8 Dry tierra templada
- 1.9 Cool winter hot tropical

Tierra Fria
- 2.1 Semitropical tierra fria
- 2.2 Low tierra fria
- 2.3 Medium tierra fria
- 2.4 High tierra fria

Desert
- 3.1 Hot tropical desert
- 3.2 Hot subtropical desert
- 3.3 Semihot and cool tropical desert
- 3.4 Cool subtropical desert
- 3.5 Tropical highland desert
- 3.6 Pampean desert

Subtropical
- 4.2 Monsoon subtropical
- 4.3 Hot semitropical
- 4.4 Semihot semitropical

Mediterranean
- 6.1 Subtropical Mediterranean
- 6.2 Marine Mediterranean
- 6.5 Temperate Mediterranean
- 6.7 Continental Mediterranean
- 6.8 Subtropical semiarid Mediterranean
- 6.9 Continental semiarid Mediterranean

Source. Food and Agriculture Organization/United Nations Educational, Scientific, and Cultural Organization. *Soil Map of the World, 1:5000 000. Vol. VI Africa*

Sahel--South of the desertic climate (3) of the Sahara, climatic regions extend in east-west belts across West and into Central Africa, becoming progressively wetter as one moves from north to south.

The first such belt is the semi-arid tropical corresponding to regions 1.3, 1.5, and 1.9, sometimes called the Sahelo-Sudanese. This covers all of northern Senegal, much of southern Mauritania and Mali, northern Upper Volta, and southern Niger and Chad. The average annual temperature is between 26 and 31°C, and average annual rainfall is between 400 and 1,000 mm. The rainy season is short to very short (2 to 4 months) and the dry season, when the wind known as the harmattan blows, is extremely severe.

The high variability of rainfall makes drought an ever-present possibility, and the crops grown are highly drought-resistant. The ratio of arable land to total land area ranges from less than 0.2 percent in Mauritania to 23 percent in Gambia. Savanna is the descriptive name applied to the natural vegetation of much of this region.

The second belt corresponds to region 1.4 and is sometimes called the Sudano-Guinean. Annual temperature averages between 24 and 28°C and rainfall between 950 and 1,750 mm. The dry season lasts 4 to 5 months, and the rainy season is longer--5 to 7 months. Region 1.4 covers southern Senegal and the southern parts of Mali, Upper Volta, and Chad.

West Africa--All of the states of West Africa outside the Sahel have major inland portions of their territories lying in region 1.4. To the south of region 1.4 lies a belt of humid, semihot equatorial climate comprising region 1.1 and sometimes called Guinean. Here, rainfall exceeds 1,000 mm. annually

and rainfall distribution is bimodal. Rainfall may reach 2,000 mm. annually in Liberia. The dry season is very short, temperatures range from 25 to 27°C and the fluctuation of the temperature is very modest compared with other climatic regions.

The coasts of Ghana and Togo lie in a drier variant comprising region 1.3 Cameroon, mainly because of altitude, has an extensive part of its territory in region 1.7.

Central Africa--Climatic region 1.4 extends across the major portion of the Central African Republic and the northern tier of Zaire.

The uplands of southern Zaire and northern Angola comprise the largest mass of climatic region 1.7 on the continent, a monsoon-influenced climate warm enough for maize and suitable for coffee growing. Gabon, much of Congo, and central Zaire lie in region 1.1, and smaller areas of 1.2 complete the central African picture.

East Africa--East Africa's climate is highly diverse because of the influence of altitude on rainfall and temperature. On the whole, East Africa is much drier than the rest of the continent lying within the same latitudes.

The desert climate 3.1, which begins on the Red Sea and extends around the horn of the continent in Somalia, reaches as far as the Equator in northern Kenya. High regions, such as the Kenyan highlands, and volcanoes and crests on either side of the Great Rift valley (1.7), are relatively well watered, receiving 1,200 to 1,500 mm. of annual rainfall. On the other hand, the Rift valley (1.3) and the plateau south of Lake Victoria (1.8) are rather dry. The heights to the east of Lake Victoria are cooler (2.3), with dryness increasing towards the coast (1.3 and 1.5) because of lower relief and, perhaps, the

influence of a cold sea current. However, the coast of Tanzania opposite Zanzibar has an abnormally high rainfall of approximately 2,000 mm. annually (region 1.1).

Rwanda and Burundi lie almost entirely in region 1.8. Sudan is desertic (3) in the north and Sahelo-Sudanese (1.5) in the south, with a sizeable area of hot semitropical (4.3) in Darfur and Kordofan. The Ethiopian highlands, with altitudes of 3,000 to 4,600 meters, receive plentiful rainfall in the summer: a maximum of 1,200 to 1,300 mm. (1.7) on the western scarp of the high plateau and less on the plateau itself (2.3). The eastern scarp of the plateau receives 500 to 1,000 mm. (1.8). The temperature is much lower on the plateau (2.3) than in the neighboring plains (1.5 and 1.7).

Southern Africa--The high plateaus of southern Angola, Zambia, Zimbabwe, and part of South Africa lie in climatic regions 2.1, 2.2, 2.3, and 2.4.

On the east, the plains of Mozambique have a low rainfall ranging from 200 to 600 mm. and a cool winter (1.9), but the coastal strip is better watered (1.3). The northern plains are appreciably more humid (1.3). On the west are the Namib and Kalahari deserts.

Finally, Madagascar's east coast and a small area in the northwest (Sambirano) have an equatorial-type climate (1.1 and 1.2); rainfall ranges from 1,500 to 3,500 mm. and the dry season is short. The high plateaus have milder temperatures (2.1 and 2.2). The hot west coast has a distinct rainy season (1.3 and 1.4). The southwestern part of the island, which is sheltered from the trade winds, has a semi-arid climate (1.5) and a rainfall of under 500 mm.

Soils

After rainfall and temperature, probably the biggest single determining influence on agricultural production is soils. Among the characteristics of soils important to agriculturalists are natural fertility, texture, drainage, depth, stoniness, alkalinity and salinity, and topography. The nomenclature adopted here is from the FAO/UNESCO soils map of Africa. 2/

Sahel--The fringe of the Sahara is occupied by cambic arenosols, which have low organic matter content and little nitrogen or phosphorus, and consequently low natural fertility. Associated with these are calcaric cambisols and eutric regosols, perhaps derived from residues of a more humid climate. Saline soils are frequent in depressions, particularly around Lake Chad. The other dominant group are the ferric luvisols and their hydromorphic variants, gleyic and plinthic luvisols. Their fertility depends on texture, ironstone content, and the possible presence of a shallow petroferric horizon. These are what are commonly known as "red" soils. Erosion problems are severe once the natural vegetation cover has been removed. Some fertile fluvisols exist along rivers. Millet and sorghum are the staple crops; peanuts and cotton are the principle export crops.

West Africa--Toward the coast, several types of ferralsols dominate. These have a low content of fertilizing elements; however, their fertility can be upgraded by replacing fallow by soil-improving rotations and by application of chemical fertilizers. Where they are deep and fine-textured with a good humus-bearing horizon they are suitable for plantation-type agriculture. The label "laterite" is frequently attached to ferralsols. Acrisols form a transition between luvisols and ferralsols. Thionic fluvisols, gleysols, and

some dune-type sandy regosols occur on the low-lying swampy coast. Crops grown for export include coffee, cocoa, oil palm, tobacco, coconut, bananas, and rubber.

Central Africa--The river valleys of the Zaire basin contain humic and dystric gleysols with varying suitability for agriculture. Their limiting feature is poor drainage. Upland regions are dominated by ferralsols and arenosols, with low agricultural value, and by dystric nitosols, of slightly higher value. The management of these soils for agricultural production is very difficult. Maize and cassava are staples.

East Africa--Rwanda and Burundi have humic nitosols, which are considered good soils for food crops such as bananas, cassava, beans, and maize, and for cash crops such as coffee, tea, and pyrethrum. Large areas of East Africa are dominated by volcanic-origin soils like mollic andosols which are agriculturally very productive. The soils are very complex in this region, with lithosols, eutric cambisols, vertisols and solonetz around the Great Rift vally. Ferralsols and acrisols are closely associated in the area between the Great Rift and Lake Victoria. Southeast of the lake are vertisols, calcaric cambisols and rendzinas. The depressions are occupied by humic gleysols and eutric fluvisols.

The cotton and wheat crops of the Gezira in Sudan are grown on vertisols, which are very heavy and difficult to work except with modern implements and which make good irrigable land under conditions of efficient drainage and a crop rotation suited to alkalinity. Savanna vegetation on vertisols provides good pasture. Vertisols are also numerous in southern Somalia, while the north has a variety of calcaric cambisols, calcaric regosols, rendzinas,

chromic luvisols, solonetz, and solonchaks. The desertic areas of Somalia and northeastern Kenya have yermosols, xerosols, and solonochaks. Basaltic parent rock has given rise to the soils of Ethiopia, which include red and fairly deep eutric nitosols associated with humic cambisols, vertisols, ferralsols and acrisols in the south and thinner cambisols, regosols, acrisols, and xerosols in the north. Recent volcanism in the Awash fault has produced lava which carries andosols.

Southern Africa--Aside from the cambic arenosols of the Kalahari Desert, this region has rhodic and orthic ferralsols, ferric luvisols, vertisols, and cambic and luvic arenolsols. Eutric fluvisols occur along the coast. The eastern and wetter side of Madagascar consists mainly of ferralsols, while the drier western side has ferric and chromic luvisols and chromic cambisols. Eutric fluvisols make good cropland along the river valleys. Cambic arenosols and eutric nitosols make up the dry uplands.

Resources

The principal resources for food production in Sub-Saharan Africa are land, labor, and capital, including human capital.

The manner in which these resources are organized as inputs in production is an integral part of the structure of agriculture and will be addressed later.

Land

Land represents the combination of all the physical influences that allow crops to be produced. To measure the productivity of land, the climatic and soil requirements of different crops can be matched to the attributes of land that govern the geographic distribution of crops, namely the number of days

when available water and temperature permit crop growth, or the growing period. Land in Africa has been classified in this manner by the FAO with regard to its suitability for various crops (figs. 10-14). 3/

Irrigation can somewhat extend the areas of suitability of land for various crops by lengthening the growing season. The controlled water supply provided by irrigation systems results in generally higher yields than obtained from rainfed production. At the same time, it does not pay to produce some low-value crops like millet and sorghum under irrigation. This will be discussed further below.

Labor

The labor force in African agriculture consists of the total of the rural population engaged in agriculture. Although there has been some decline in the proportion of the labor force in agriculture, in most African countries it is still above two-thirds (table 24). The proportion ranges from 92 percent in Rwanda to 36 percent in Congo. In some countries, including Ghana, Nigeria, Sierra Leone, Togo, Congo, Mozambique and Zambia, the share of the labor force in agriculture dropped by 10 percent or more between 1960 and 1975.

In most countries, the agricultural labor force is composed primarily of families cultivating land for their own subsistence. Plantation or estate labor, and employment on state farms, are less significant.

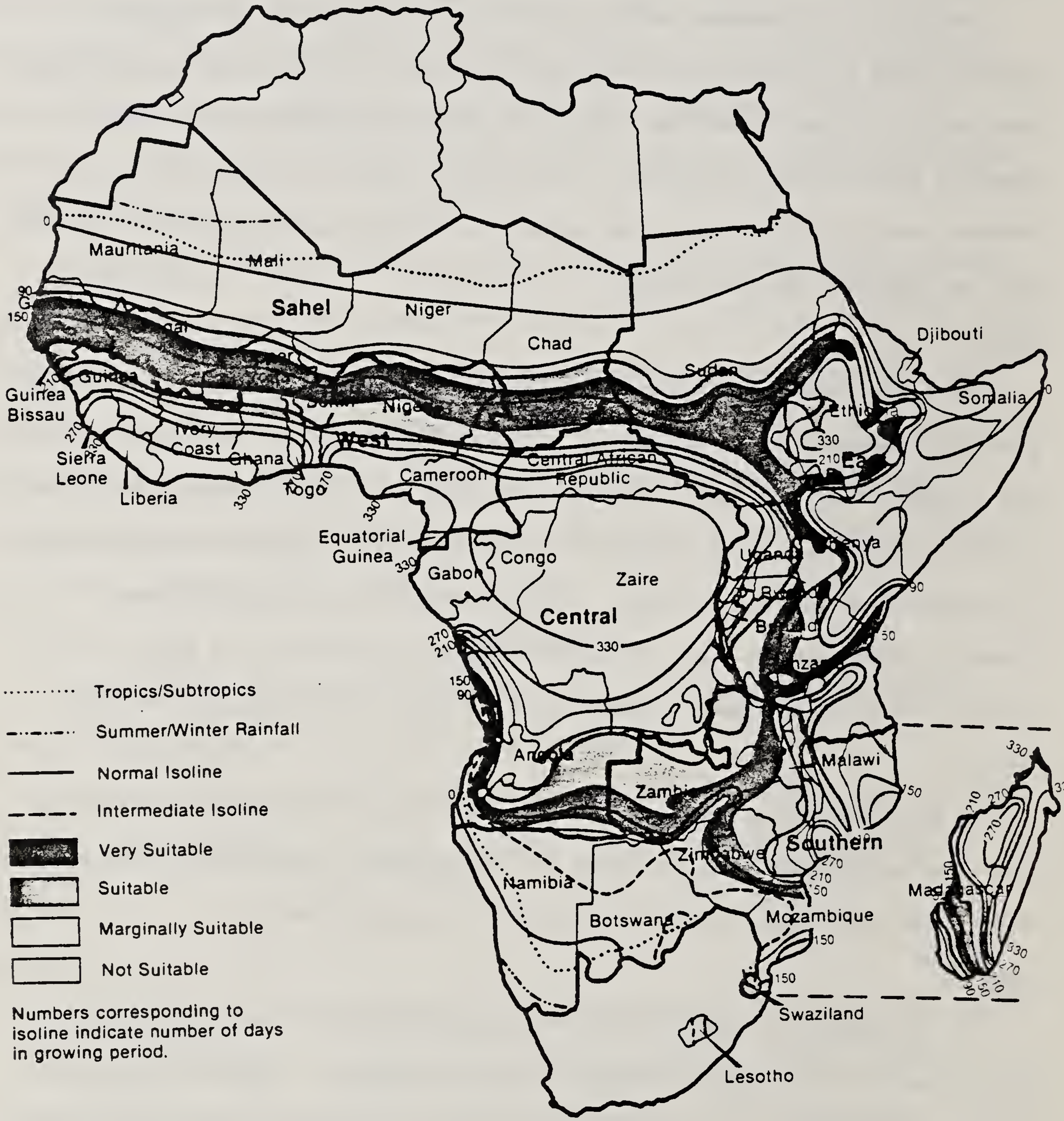
Capital

The investment of capital in African agriculture is low, proportionate in this respect to the small cash flow of most producers. Tools are few and simple. Buildings, apart from houses, consist for the most part of structures

Figure 10

Sub-Saharan Africa

Millet: Rainfed Production

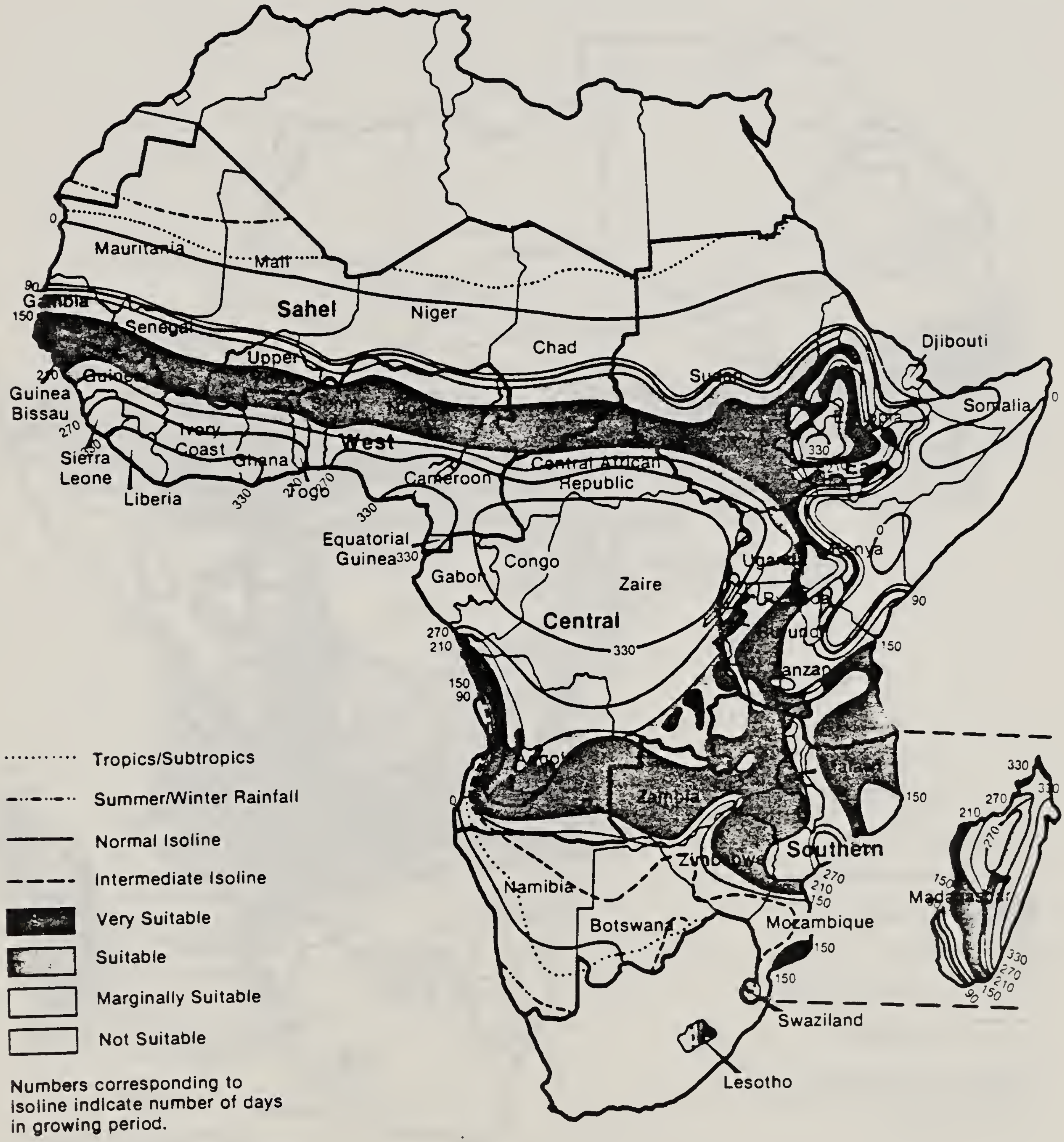


Source: Food and Agriculture Organization, Report on the Agro-Ecological Zones Project, Vol. I.

Figure 11

Sub-Saharan Africa

Sorghum: Rainfed Production



Source: Food and Agriculture Organization, Report on the Agro-Ecological Zones Project, Vol. I.

Figure 12

Sub-Saharan Africa
Maize: Rainfed Production

Source: Food and Agriculture Organization, Report on the Agro-Ecological Zones Project, Vol. I.

Figure 13

Sub-Saharan Africa

Wheat: Rainfed Production

Numbers corresponding to isoline indicate number of days in growing period.

Source: Food and Agriculture Organization, Report on the Agro-Ecological Zones Project, Vol. I.

Figure 14

Sub-Saharan Africa

Cassava: Rainfed Production

Source: Food and Agriculture Organization, Report on the Agro-Ecological Zones Project, Vol. I.

Table 24--Percentage of labor force in agriculture, in selected countries, Sub-Saharan Africa

Region and Country	Percentage of labor force in agriculture	
	1960	1978
	Percent	
Sahel:		
Chad	95	86
Mali	94	88
Mauritania	91	85
Niger	95	91
Senegal	84	77
Upper Volta	92	83
West Africa:		
Benin	54	46
Cameroon	87	82
Ghana	64	54
Guinea	88	82
Ivory Coast	89	81
Liberia	81	71
Nigeria	71	56
Sierra Leone	78	67
Togo	80	69
Central Africa:		
Angola	69	60
Central African Republic	94	89
Congo	52	35
Zaire	83	76
East Africa:		
Burundi	90	85
Ethiopia	88	81
Kenya	86	79
Rwanda	95	91
Somalia	88	82
Sudan	86	79
Tanzania	89	83
Uganda	89	83
Southern Africa:		
Lesotho	93	87
Madagascar	93	86
Malawi	92	86
Mozambique	81	67
Zambia	79	68
Zimbabwe	69	60

Source: World Bank, World Development Report, 1980.

for storing grain. The grain itself may be an important component of capital. A total capital investment amounting to US$ 6.50 per farm is not unusual. 4/ Societies which herd livestock possess considerably more capital, on average, embodied in their animals; often these societies do not own any land, but make their living by entering into various forms of grazing arrangements with sedentary peoples and selling or exchanging animal products like meat, milk, cheese, and hides, in addition to consuming products of their herds.

Exceptions to the above rule of low capital investment are, of course, the large commercial farms and government-owned plantations found in several African countries. These often have considerable capital invested in machinery, animals, or irrigation infrastructure. In the case of the Gezira irrigation project in Sudan, the Government made a large investment on behalf of smallholders, who must, however, conform to certain government-imposed prescriptions in order to gain the benefits of use of this capital.

Human capital is likewise scarce. The level of education is, in general, low. In 1975, only a handful of African countries--Somalia, Tanzania, Madagascar, Congo--had an adult literacy rate of 50 percent or higher. Most of the rural labor force has no significant formal education in agriculture.

STRUCTURE OF FOOD PRODUCTION

While the export crops of Africa, under the pervasive influence of colonial interests and metropolitan markets, evolved their own particular production and marketing arrangements, food production throughout the continent continued with very little change, although coming increasingly under the influence of government interventions of various kinds. Today food

production in Africa exhibits a number of different structures. These may be classified according to their use of land, the primary input in production, or according to socioeconomic organization.

Land Use Systems

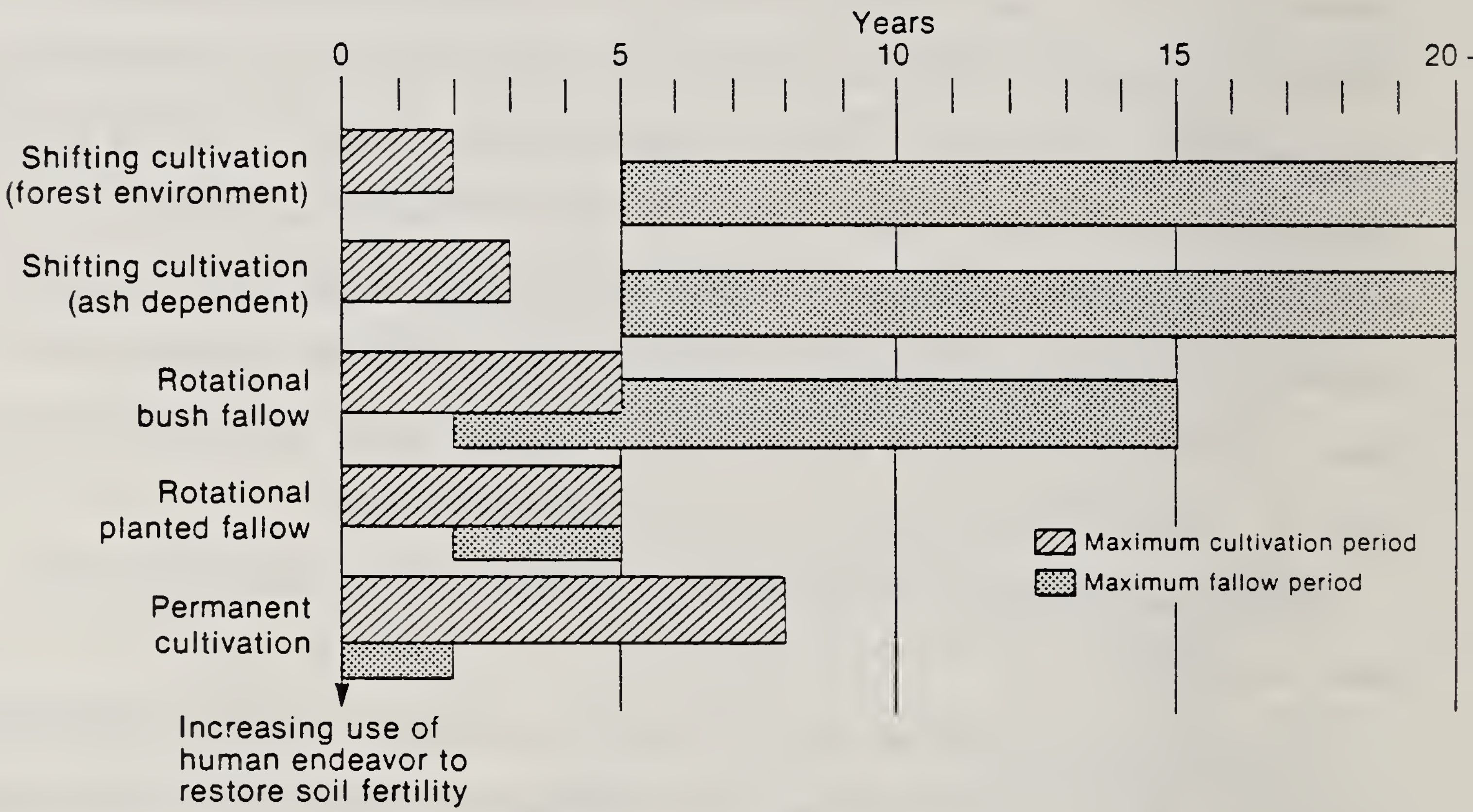
Farming systems have been conveniently classified according to the manner in which land is used in production. 5/ Land may be used for crop production or for grazing, or both. It may be used more or less intensively for these purposes, in accordance with its fertility, population pressure, and other factors (fig. 15). Due to the fact that land has generally been plentiful in relation to population size and to the rapid decline of fertility of tropical soils following cultivation, the most common farming systems in Africa are at the extensive end of the scale. The practices of clearing land for cultivation, and of fallowing land after cultivation, allow one to classify systems by choosing some arbitary values of a ratio between the number of years in a cultivation cycle and the length of that cycle, as Ruthenberg has done. 6/ The following systems can thus be distinguished:

Nomadic pastoralism--A system under which land is not cultivated but is used for grazing.

Shifting cultivation--The most extensive cultivation system, representing a system in which several crop years are followed by several fallow years and less than two-thirds of the potential crop land is cropped annually. Ruthenberg points out that, because the shifting of fields within a broad area of wild vegetation usually results in the gradual relocation of the farming population, shifting cultivation sometimes, but not always, implies migration of villages.

Figure 15

Sub-Saharan Africa
Major Cultivation Practices



Source: A.T. Grove and F.M.G. Klein, *Rural Africa*

Rotational fallow--The next most intensive system, representing a system in which more than two-thirds of the potential cropland is cropped annually. At this point, as Ruthenberg observes, "we can hardly speak of a shifting of the fields any more." 7/

Permanent cultivation--Crop cultivation without fallow. This system includes the cultivation of tree crops. Natural or chemical fertilizer must often be used to restore soil fertility.

In both shifting and rotational systems, the cropping pattern is the principal vehicle for adjusting to the natural environment. Diminishing soil fertility means less demanding crops are planted toward the end of the shifting or rotational cycle. Adjustments to seasonal differences are also made by planting crops whose planting and harvesting can be staggered to conform with local conditions. Broadcast sowing and what often appear to be "disorderly" fields help provide ground cover in areas whose soils would rapidly deteriorate without them. The result is a locally adapted cropping pattern which can be quite complex--both in terms of its variety and in the social division of labor which supports it.

Animals play a large role in the economies of many sedentary African societies. There are two methods by which farmers engage in mixed crop-livestock farming: they may keep their own animals on their own farms, like the Swazis, or they may turn them over for grazing to an outside group, as many farmers in the Sahel do to the Fulani, a society specialized in herding.

Socioeconomic Organization

Food production in African agriculture takes place in two, usually separate, sectors. The first is the sector composed of many small units,

called the subsistence sector. The second consists of a relatively small number of large-scale agricultural enterprises of various kinds. Formerly many such enterprises were in the hands of colonial overlords; now national governments have taken many of them over. Some have been split up and some continue to be privately operated. In these large-scale units, decisionmaking is centralized in the hands of managers who are either government servants or closely linked to government, and world commodity markets exert a powerful influence on decisions.

In the subsistence sector, the objective function of each unit in the system is to minimize the risk of failure in a naturally difficult and unpredictable environment. 8/ This objective function means that subsistence farmers organize their production, trading, and consumption according to a pattern that will make them as self-sufficient as possible. This implies that they will give first priority to filling their granaries or preserving their livestock herd. It does not mean that many producers sell no cash crops or livestock products. On the contrary, such sales are necessary for producers to purchase basic items like salt and cloth, either in bush markets or in more highly organized central markets.

Because the weather is unpredictable and exerts a great influence on output, each unit's total production in any 1 year will be highly unpredictable, and some carryover of stocks from year to year will be rational (a deduction confirmed by empirical observation). Moreover, in aggregate, the supply of such staple grains as millet, sorghum, and maize shows great variability from 1 year to the next.

Land Tenure

Communal land tenure systems are associated with land extensive, subsistence agriculture. Throughout much of the continent, individuals do not have permanent, transferable title to the land they cultivate. Membership in a tribe, family or community--plus a demonstrated intent to use the land--gives individuals occupancy and use rights to a portion of land. How hierarchial land control is varies substantially. The basic pattern of communal land tenure, however, pervades the continent.

Low population density and traditional technology that was netural to scale prevented the concentration of landholding through much of the continent. There is evidence that early settlers in villages obtained better quality land, so the system was not entirely egalitarian. However, new families in a village were entitled to use of the land they cleared of bush.

The exceptions were those places where a feudal system developed, as in Ethiopia, and those places where the advent of colonial rule resulted in white settler agriculture. Here, landholding became concentrated, as may be seen from table 25.

Within each family, there are usually two types of fields: common fields whose management is controlled by the family head and individual fields on which control is exercised by other individuals residing in the family (e.g. men, including stranger farmers, 9/ women, and children). Under this system, the family head provides from the common field at least some of the food required to feed the individuals within the family. He has also traditionally been responsible for the taxes paid by the family. In return, individuals within the family incur various work obligations with respect to the common

Table 25--Concentration of landholding, selected countries, Sub-Saharan Africa

Region and country	Survey date	Survey coverage	Gini ratio 1/
Sahel:			
Chad	1972-73	Traditional sector	.37678
Mali	1960	National	.47696
Niger	Early sixties	National	.4682
Senegal	1960-61	2/ National	.49178
West Africa:			
Cameroon	1972-73	Traditional sector	.4447
Guinea-Bissau	1960-61	National	.39737
Ivory Coast	1973-75	3/ Traditional sector	.4219
Liberia	1971	National	.7536
Nigeria	1972	4/ Western State	.40775
Nigeria	1963-64	5/ Northern region	.17845
Sierra Leone	1970-71	6/ National	.44705
Central Africa:			
Central Afr. Rep.	1973-74	Traditional sector	.37205
Congo	1972-73	Traditional sector	.28874
Gabon	1974-75	Traditional sector	.56414
Zaire	1970	Modern sector	.88389
East Africa:			
Ethiopia	1966	Harage provence	.83529
Kenya	1976	7/ Large farms	.76799
Kenya	1969	8/ Small holdings	.5475
Somalia	1968	9/ Five districts	.55483
Sudan	1964-65	10/ Three provences	.49505
Tanzania	1964	11/ Large commercial farms	.76657
Southern Africa:			
Botswana	1968-69	Traditional sector	.59823
Lesotho	1970	National	.39031
Malawi	1968-69	National 12/	.36253
Mozambique	1970	National	.70518
Namibia	1959-60	Non-Bantu holdings	.073835
Swaziland	1971-72	Subsistence sector	.399
Zambia	1970-71	Commercial sector	.75698
Zimbabwe	1960	European holdings	.60753

1/ The Gini ratio is a simple, single-value measure of concentration. Its value varies from zero, signifying perfectly equal distribution, to unity. Geometrically, the Gini ratio may be represented as the ratio of the area between the diagonal and the distribution curve to the total area under the diagonal of a square on which cumulative percentage of population are plotted along one side and cumulative holdings of the variable being measured are plotted along an adjoining side.

2/ Excluding Fleuve region.

3/ Holdings less than 100 ha.

4/ Farm crops only.

5/ Farm crops only. Excludes commercial, government and corporation farms and plantations.

6/ Cropland.

7/ Holdings in the former scheduled areas and in the coastal strip above 8 ha. in size.

8/ Registered small holdings.

9/ Afmedou, Coriolei, Gelib, Giamama, and Kisimayo Districts.

10/ Blue Nile, Northern, and Khartoum Provinces.

11/ Covers any farmer in charge of a farm of 5 acres or more outside any town, or of any size within a township; also any farmer employing skilled labor and management and using large amount of capital equipment and labor.

12/ Land under crops.

Source: Data from Charlotte E. Lott (ed.), Land Concentration in the Third World: Statistics on Number and Area of Farms Classified by Size of Farms, Madison, Wisconsin: Land Tenure Center, University of Wisconsin, April 1979. This source listed original sources. Gini ratios computed by ESCS/USDA.

fields (such as 4 days work per week on the common fields, 3 days on private fields).

As population has increased, farm size has decreased and land has come to be viewed more strongly as a private good than as a public good, with consequent impact on the traditional relationships of family individuals with respect to land use. As land value increases owing to its increasing scarcity, landowners are less willing to rent it out on anything less than cash terms, and for shorter and shorter periods. 10/ This trend has implications for accelerating loss of soil fertility. Moreover, distributional problems have been aggravated as influential groups attempt to get control of larger amounts of cultivated land in villages. Finally, fragmentation of landholdings has resulted from the operation of traditional inheritance laws. 11/ In many areas of Africa today it is not uncommon for villagers to own land in a large number of widely separated fields. This last aspect, it has been pointed out by researchers, is not altogether harmful to the welfare of the village as it serves to distribute soil types and micro-climates with their variations in rainfall more equitably among the villagers.

A particular variant on the landholding pattern in West Africa is the stranger farmer system. Stranger farmers are seasonal migrants who come to an area to work during peak labor demand seasons, often on cash crops. In return for his labor, the stranger farmer is allocated a piece of land on which to grow his own cash crop for a specified share of the time; he is also given his food by the landholding family. In recent times the system has been modified to the extent that stranger farmers are often required to engage in some food

production as well, and monetization of their rent is also increasingly required.

In some regions of Africa, land sales were established for indigenous, as well as expatriate production. The mailo land system in Uganda is an historical example; the granting of an individual title in Kenya as part of land tenure is a contemporary one.

Some scholars argue that as the transition to more permanent, input-intensive agriculture becomes imperative, changes in land tenure will also be necessary. This would appear to apply to some regions more than others. There are two major claims in this respect. First, without some relatively permanent stake in a well-defined piece of land, investment incentive will not be adequate. Communal holdings are vulnerable to the "problem of the commons." There is underinvestment in measures which would benefit all those using the land, because it is expensive--and sometimes self-defeating--for individuals to undertake them without wider cooperation. Second, if loans are to be made available to subsistence farmers, clear title to land is frequently preferred (or required) as a way of securing the loan. Abolishing communal land tenure in societies practicing subsistence agriculture may not be a necessary step toward more viable intensive cultivation. However, maintaining it will require attention to the special problems it creates, and developing effective ways of coping with them.

The following is a brief review of salient land tenure features:

Sahel and West Africa--Smallholders are responsible for the bulk of food production. The subsistence sector predominates, although a few larger-scale, mechanized units produce rice and maize. In Ghana, Nigeria, and the Ivory

Coast, however, cash crops such as coffee and cocoa are important on small-scale farms. Oil palm and rubber are grown on large, state-owned plantations, while sugar production takes place on large-scale complexes. Similarly, in Cameroon, there are a small number of government- and privately-owned industrial plantations for oil palm and rubber. Approximately half the total acreage of rubber in Liberia is operated by foreign-owned concessions.

In Benin, Togo, and Nigeria, the respective governments are encouraging the establishment of larger-scale units. In Togo, where 50 percent of the cocoa area is cultivated under sharecropping or tenancy arrangements, agrarian land reform is claimed to facilitate the merging of small fragmented plots and the use of more modern agricultural equipment. The Government of Benin intends to develop a series of highly mechanized state farms 1,000 hectares (ha.) or more in size. In Nigeria, the land tenure system differs among States although it is predominantly communal. However, in recent years there has been a movement toward freehold tenure. Rapid population growth has exerted pressure on available land. Many farmers have ill-defined rights to the land.

Large-scale mechanized farming has received strong encouragement in Ghana. There are estate projects for cotton, oil plam and sugarcane, and plantation schemes for rubber and coconut production. The present government, however appears to be placing greater emphasis on the smallholder secton, where communal land tenure is widespread. In Guinea, Government policies are currently emphasizing collective farming. Village-level production brigades, equipped with tractors or ox-drawn ploughs, have been established to cultivate

communal farm units. However, their performance has met with limited success, and yields are generally lower than those of smallholders, who account for 80 percent of total agricultural production.

In Guinea-Bissau, the Government has stressed the promotion of small-scale family farms but does not exclude the establishment of state farms. The situation in Sierra Leone is similar.

Central Africa--Land tenure is not a major production constraint at present. The traditional land tenure system under which the tribal authorities allotted plots for building and cultivation has been modified over the years to try to orient it toward commercial rather than family subsistence production. The colonial governments encouraged commercial farms under private ownership to produce the export crops, but the small traditional farms continued to produce almost all the food crops. Attempts to organize the smallholders to produce food crops for sale began in the fifties with the paysannats, and have continued until the more recent establishment of cooperative farms in Angola and Congo, and diverse smallholder projects in Zaire. All these experiments with rationalization and modernization of tenure have reached only a minority of the food producers; food is still produced on small holdings under traditional tenure.

East Africa -- Smallholders produce the bulk of agricultural products. The importance of the subsistence sector varies from county to county. Production for markets is little in Rwanda and Burundi, and large in Sudan and Kenya. Sudan has three distinct sectors: state-controlled, participatory irrigation schemes; large-scale private, mechanized farming under rainfed conditions; and traditional small farmers, who account for about 60 percent of

total production. Kenya's farms represent more of a continuum from small subsistence holdings to large units controlled by individuals, cooperatives, and companies. In the other countries large units are generally limited to some cash crops, with the exception of Ethiopia's expanding state farm sector and a few state farms in Tanzania. Somalia is particular in that more than half its population are nomadic and raise livestock.

Throughout the region, smallholders grow most of the export crops, of which coffee and cotton are, the most important. Large estates play a more limited role, mainly growing sisal, tea, and in Kenya, pineapples. Even tea has been successfully extended to small farmers in Kenya, although it was once considered suitable only for plantations. Smallholders have been integrated into the market economy more through export crops then food crops. This reflects colonial priorities which have been continued since independence.

Southern Africa -- Agriculture is basically dualistic: a large traditional, mainly subsistence sector and a sector composed of larger, modern units are typical. This dualism has generally resulted from control of land by white farmers and/or investments by private firms.

The most extreme situation is in Zimbabwe, where approximately 6,000 white commercial farmers and some plantations, controlling almost 50 percent of the total land areas and employing a great deal of wage labor, produce most of the marketed agricultural goods. Over half the population is restricted to Tribal Trust Lands (TTL), less fertile areas representing about 40 percent of the land. Farming in the TTLs takes place on small units with little marketed surplus produced and faces problems of overgrazing, crowding, and lack of infrastructural development. Falling in between these extremes is a small

group of African commercial farmers, perhaps 8,000 in the African Purchase Areas, which comprise under 4.0 percent of total land.

Dualism is also an issue in Zambia. Approximately 500 to 600 large-scale commercial farmers, of whom half are European, produce about one-half to two-thirds of the marketed output of maize, the staple food, on leasehold land. In Mozambique, there have been some structural changes. A broad subsistence sector still exists but the former Portuguese commercial farms, primarily small and medium sized, have been consolidated into state farms, along with some of the old plantations. Some 4,000 farms cover nearly 50 percent of the farmland. Some "communal" villages have been established and are to be expanded.

Small farmers predominate in Malawi, where virtually all arable land is cultivated, but an estate sector produces most of the cash crops, such as tea, sugar, and tobacco. During recent years when Zimbabwe's exports were restricted, tobacco became more important. Agriculture in Malawi is mostly labor-intensive and in general has had successful growth. In Swaziland there is a dramatic contrast between the 600 to 800 large modern farms and the traditional sector. About 70 percent of the population live on mainly subsistence farms, covering about half the land area. A large proportion of the modern farms are owned by foreigners and private companies.

Small-scale farming predominates in Madagascar. The average size of family holdings is in the range of 0.5 ha. to 2.0 ha. and units are often fragmented. There are also a few commercial plantations, and more state farms are being established.

Labor

Despite the generally high proportion of the labor force in agriculture in African countries, labor can be considered a scarce resource from the perspective of the production unit. This is because the seasonality of production in many areas creates sharp peaks in demand for labor, and because the degree of mechanization is low, both with respect to food crops and cash crops. The result is the appearance of bottlenecks in the production cycle.

Men, women, and children all form part of the production unit`s labor force. In many societies, the roles are distinct. In Diola society (Casamance region, Senegal), it is the women who transplant, care for, and harvest and pound the paddy, the major subsistence crop, while the men grow peanuts, the main cash crop. In Sarakollé society (eastern Senegal), the division of labor is the inverse. When there is a division between food crop and cash crop production, men generally find a principal role in cash cropping.

The large measure of participation of women in food production is a distinguishing feature of Sub-Saharan Africa. This has been due to tradition or, particularly in modern times, to the prevalence of outmigration of men from the village. In some countries, like Lesotho, outmigration is on such a large scale that women play the major role in food production.

Risk Bearing

The attitude toward risk and the mechanisms used to alleviate risk are important structural aspects of food production in Africa. Faced with an identical set of policy-determined conditions, farms in the subsistence sector and in the large-scale farming sector may behave quite differently.

Large-scale farms, be they private or public-sector operations, may be said to follow a profit-maximizing objective function and will use purchased

inputs up to the point where their marginal value product just equals their marginal cost. Subsistence-sector farms, on the other hand, behave in their production decisions in a manner that considers profits but also palces considerable emphasis on risk minimization. In actual fact, this is an oversimplification.

Ancey has identified no fewer than nine different levels of decisionmaking within the unit variously described as the "farm," "household," or "production/consumption unit" in the subsistence farming sector in West Africa. 12/ He also identified no fewer than 14 goals, including self-sufficiency, production of a marketed surplus, acquisition of net monetary income, acquisition of nonagricultural income, intra-annual security, interannual security, diversification of activities, and leisure. Among these societies, he found, there is constant conflict and resolution of goals occuring at the various levels. For example, the goal of people working on individual fields is likely to be profit maximization, while that on the common field is likely to be food security.

The sometimes unexpected results obtained by government extension programs operating in the subsistence sector can often be ascribed to a lack of understanding of objective function. Hopkins has shown, on the basis of a linear programming model, the rationality of decisionmaking by Wolof farmers in Senegal confronted with the recommendations of an extension program. 13/ She found that resources constraints may prevent most types of farmers from adopting the full recommended improved technology package, and that better returns may be achieved using available resources to farm larger areas less intensively and through expanding the range of crops grown. Thus, there is no

reason to believe that merely providing inputs like fertilizer will be sufficient to induce subsistence-sector farmers to use them.

Here again, cropping patterns provide subsistence farmers with an important mechanism for adjusting to an environment filled with risks of yield and price variability. Planting cash crops late after food crops have become well established, and the tendency during drought periods to cut down on the production of cash crops in favor of food crops have been identified as such adjustment mechanisms in the Sahel. Others are the common practices of mixed cropping and the allocation of crops among scattered fields of a single holding. Until we possess a significant body of longitudinal farm management data together with longitudinal data on weather and real prices faced by the farm unit, the analysis of risk-bearing among subsistence-sector producers in Africa will have to remain at the present stage of identification of mechanisms.

THE PRODUCTION POTENTIAL

As population pressure grows, and the demand for marketed crops increases, subsistence agriculture has been pressed to make a transition to more permanent cultivation based on techniques for restoring soil fertility through a combination of natural and manufactured inputs. Failure to make this transition successfully will inevitably mean both a deterioration of the natural resource base and an increase in rural poverty. Similarly, in some areas, increased population and a rising demand for marketed meat has begun to put pressure on traditional nomadic practices. Environmental damage and increasing poverty and malnutrition are likely if a successful transition to more viable sedentary practices is not made.

Clearly, not all areas of the continent are presently feeling the pressure to make such transitions. However, even with relatively abundant land resources, such land extensive subsistence systems will be difficult to sustain as population continues to grow rapidly.

In the section which follows, the array of prices facing the producer, be he a smallholder or a national government, will be taken as given. We are concerned for the moment with the utilization of resources under price relationships which are fixed and known, and examining whether there is potential for increasing food production using these resources. Subsequently, we will examine the response of production units to price changes.

Additional Available Resources

Some potential exists for increasing food production in Sub-Saharan Africa by greater, or more efficient, use of the traditional resources land and labor.

Land

Clearing additional land has been the traditional means employed in Africa for expanding food production to meet the needs of population growth. Data on land cropped are published annually by most African governments. In the absence of data sets from several African countries, the present study has relied on AID data. 14/ These data show that in recent years the amount of arable land has increased in most African countries, with a few exceptions. Arable land increased by 12.8 percent in West Africa between 1961-65 and 1976, by 9.3 percent in Central Africa by 33.7 percent in East Africa; and by 18.7 percent in Southern Africa, while the Sahel showed a decrease of 2.5 percent for the period. While there is always a danger in making point-in-time comparisons to show trends in a variable subject to significant yearly

fluctuations, these data do show generally a modest annual increase in the amount of land cultivated over much of the continent. Net decreases were registered by Mali, Ghana, and Cameroon.

The potential for food production from clearing additional land in tropical Africa has been described by some authorities to be very large. 15/ In Zaire, for instance, a country with extensive rainforest, annual food crops accounted for barely 1.8 percent of the land area in the 1970-74 period. Two major problems diminish the value of this potential, however. One is that newly-cleared rainforest soils become subject to severe degradation; raindrop impact results in detachment of soil particles and consequent sealing of the soil surface, reducing water infiltration and retention (thereby reducing the value of these soils for agricultural production), and increasing runoff and erosion damage. The other major problem connected with clearing rainforest is cost; the clearing operation may require an initial investment of something on the order of magnitude of $3,000 per hectare.

Land clearing is obviously a simpler proposition in the less densely wooded savanna areas north and south of the equatorial zone. Even here, however, destumping and intensive cultivation without concomitant measures for controlling erosion and fertilizing soils may lead to serious declines in soil fertility. 16/ The associated costs of settling agriculturalists on these lands are by no means negligible, as has been discovered by the public authority in Upper Volta concerned with the development of the Volta valleys where an attempt has been made to eradicate onchocerciasis.

Along the Shebele River in Ethiopia, the Government is resettling small farmers from the drought-prone, overpopulated areas to the north. Some

swampland reportedly is still available for development in Rwanda, the most densely-populated African country, and polder land can still be reclaimed from Lake Chad. Parts of the inland delta of the Okavango in Botswana can be reclaimed for rice growing and other crops.

Since the total supply of land is fixed, population is increasing, and cultivated area is expanding to allow food production to keep up under the land-extensive system of agriculture further expansion of cultivation is limited. In terms of space, these limits take the form of land planted by members of one village "bumping into" the land of adjoining villages. In terms of land utilization, the limits become manifest in declining crop yields as fallow periods practiced under the rotational bush fallow system are progressively shortened in order to increase the frequency of cropping. 17/ Both these limits have long since been reached in the peanut basin of Senegal, the Mossi Plateau of Upper Volta, the highlands of western Kenya, and other densely populated areas where intensified agricultural production has already been forced as a solution. Declining soil fertility often can only be countered by application of chemical fertilizers, and this requires investment. Thus, it is not surprising that in the Senegal peanut basin and in Rwanda the proportion of arable land devoted to production of the cash crops peanuts and coffee has remained roughly constant as the average size of holding has decreased.

An aspect of land use that should not be neglected is grazing, and here there may be prospects for increased productivity through better management of grazing lands. Overgrazing and frequent burning of pastures are common in East Africa with its large livestock populations, and to a lesser degree in

West Africa. Ethiopia, Sudan, and Tanzania maintain the three largest cattle herds in Africa, while Rwanda has the highest density of cattle. In Botswana and Namibia, livestock are economically more important than crops. Better management of grazing lands, within the framework of the values of the societies who live by them, is a highly desirable way of expanding Africa`s resource base.

In sum, newly-cleared land can be expected to contribute to an increase in food production, but for certain regions not so much as it has done in the past. More efficient use of existing grazing land is possible. Two other important ways of using land more efficiently are irrigation and mixed cropping.

Irrigable Land

Irrigation is controlled water management and represents a means of enlarging agricultural production through intensifying use of the land.

Water determines yield, within the limits set by climate, soils, and the genetic potential of the crop. Although almost all African farmers, particularly those in the semi-arid areas where the rainy season is extremely short, attempt to retain some runoff and to divert trickles of water onto their fields by means of small dykes and channels, irrigation 1ill be defined in this report as the controlled provision of water in amount and timeliness such as to maximize crop yield.

Irrigation as used in this report thus excludes the practice, traditional in West Africa, of growing crops by the flood recession method along the banks of the major rivers (Rivers Senegal, Niger, Volta, Benue, Chari, Logone) and their tributaries, taking advantage of the seasonal rise and fall of the water

level. The total area of such cropping is reported to run as high as 100,000 ha. in Senegal and Mauritania; 150,000 ha. in Mali, Upper Volta, and Niger; and 40,000 ha. in Chad and northern Cameroon. It also excludes the growing of crops under water runoff in bottomlands (French: Bas-fonds); though scattered, their aggregate area is quite impressive, amounting to an estimated 150,000 ha. in Mali, Upper Volta, and Niger alone. 18/ In both these methods, the farmer has no control over either the amount or the timeliness of the water supplied to his crop, he of necessity plants crops which possess a wide tolerance of water supply conditions in order to assure himself of some return.

The same body of AID data cited above shows that the proportion of arable land under irrigation in African countries is very small, even in countries with the biggest irrigation projects like Sudan and Mali. Irrigated land, however, has expanded at a much more rapid rate than total arable land in all five regions of Africa. Countries showing the highest rates of growth in this respect in the period 1961-65 to 1976 are Ivory Coast (400 percent), Sierra Leone and Kenya (300 percent), Cameroon and Burundi (167 percent), Malawi (150 percent), Mali (109 percent) and Gambia (108 percent). In countries which possessed a significant irrigated acreage prior to 1961-65, Sudan and Madagascar, the recent percentage increase has of course been much less.

As irrigation development depends on a favorable combination of land (especially topography) and water, the areas suitable for irrigation are necessarily limited. In West Africa, the French organized an ambitious scheme to use the inland delta of the Niger River in Mali for irrigation beginning in the thirties, and this presently accounts for approximately 60,000 ha. of single-cropped land plus another 10,000 ha. of double-cropped land.

The variability of flow of the major rivers in West Africa has proved a particularly serious obstacle to the development of large-scale irrigation schemes. The French also constructed the Richard-Toll irrigated perimeter near the mouth of the Senegal, as well as smaller perimeters further upstream relying on diversion channels. Mauritania has the M`Pourié irrigation perimeter.

Madagascar very probably has the longest tradition of continuous irrigated production of any country by virtue of the arrival there of rice plants from Asia aboard outrigger canoes a few centuries B.C. Today, it is the continent`s single biggest rice producer. Sudan has the Gezira scheme, which dates from the interwar period and which is still being expanded, as well as a number of other irrigation projects. Irrigation schemes exist in Kenya (Mwea, Hola, Perkerra, Ahero, Bunyala, Bura), Tanzania (Kahe, Mbarali, Kilangali, Ruvu, Mtibwa, TPC Sugar Estate), Malawi and Zambia.

Farther south, the Massengir Dam on the Limpopo River in Mozambique, construction of which began in 1972, irrigated 4,000 ha. in the 1976-77 crop year, divided among a state farm and six cooperative farms, and an additional 12,000 ha. in the 1977-78 crop year. It is estimated that currently about 20 percent of Zimbabwe`s agricultural production is from irrigation. Irrigated perimeters also exist in Swaziland, which has a high proportion of its cropland under irrigation. Small-scale irrigation, however, appears to be less widespread in East and Southern Africa than in West Africa.

Not all the irrigated acreage in Africa is devoted to food production by any means. In fact, the history of large-scale irrigation schemes makes it abundantly clear that almost from their inception these schemes come under

pressure to produce higher-value cash crops, mainly cotton in West Africa and the Gezira and sugarcane in East Africa. This results from the need to recoup heavy initial investment burdens and high operating and maintenance costs. (The Richard-Toll perimeter in Senegal, for instance, required a state subsidy every year between 1946 and 1960 amounting to between 8 and 50 million CFA francs annually).

There exists potential for expanding irrigated food crop production in Africa from both small-scale and large-scale projects. Estimated maximum potential for irrigation from capture of short-distance runoff in the Sahel is in the vicinity of 300,000 ha. This would, however, require the construction of 7,000 small dams at a total investment in excess of 2,100 billion CFA francs, not counting the cost of installations in the irrigated perimeters themselves.

As for the potential for large-scale irrigation projects in the Sahel (see table 26), engineering studies indicate the feasibility of a number of projects. The projected Manantali Dam on the Senegal could irrigate 340,000 ha., and the smaller Diama Dam further downstream could irrigate another 50,000 ha. On the Niger, a dam at Tossaye could command a maximum of 800,000 ha., wiile creation of a dam with reservoir at Selingué could bring 62,000 ha. under double-cropping plus add one more annual crop to production on Office du Niger land. Various feasibility combinations on the Chari and its tributaries have been studied; among the more interesting are a dam on the Logone in Chad (between 16,000 and 27,000 ha.), one on the Pendé in Cameroon (8,000 ha.), or else a projected dam at Goré on the upper Logone (95,000 ha.) and a projected Koumbam Dam on the Vina (120,000 ha.). The Chari itself; while carrying a

Table 26--Major irrigation potential, Sub-Saharan Africa

Region, country, and project	Estimated newly irrigable area
	Hectares
Sahel:	
Chad--	
Logone	16,000-27,000
Goré	95,000
Koumbam Dam	120,000
Chari	80,000
Gambia, Gambia River	60,000
Mali, Selingué Dam	62,000
Mali and Niger, Tossaye Dam	800,000
Senegal--	
Manantali Dam	340,000
Diama Dam	50,000
Upper Volta, White, Black and Red Volta Rivers	50,000-65,000
West Africa:	
Cameroon, Pende	8,000
Ghana, Lake Volta	25,000
East Africa:	
Kenya--	
Tana River	115,000
Lake Victoria	35,000
Sudan, Gezira and other	1/ up to 652,000
Tanzania	16,000
Southern Africa:	
Mozambique--	
Massengir Dam	90,000-341,000
Cabora Bassa Dam	1,000,000-plus

1/ Calculated by USDA/ESCS on the basis of 1959 Nile Water Sharing agreement with Egypt, completion of Jonglei Canal, and estimated increased efficiency of water management.

Source: Various reports.

huge flow in the rainy season, does not reportedly lend itself to large-scale dam works, but it is estimated that an additional 80,000 ha. could be irrigated along its course without such works.

Smaller potentials exist along the Gambia (up to 60,000 ha. of double-cropped rice) and along the White (25,000-30,000 ha.), Black (20,000-30,000 ha.) and Red (possibly 5,000 ha.) Voltas. Downstream in Ghana, Lake Volta, formed by the Akosombo Dam, could be used to irrigate nearly 25,000 ha., but more studies are reportedly needed on the hydrological, engineering and agronomic aspects. Also in Ghana the Kpong irrigation project, when completed, is expected to add another 5,200 ha. to the irrigated sector.

Some of these large-scale projects would take advantage of the presence of relatively fertile fluvisols in the river valleys which, when suitably irrigated and drained, can be highly productive.

In East Africa, Sudan has the largest irrigation potential, one that is limited by the amount of water Sudan can use from the Nile rather than by land availability. The potentially suitable land for large-scale irrigation in Kenya has been placed at 160,000 ha., of which 115,000 are in the Tana River basin and 35,000 are in the Lake Victoria basin. A total of 16,000 ha. are planned for irrigation in Tanzania, where smallholder irrigation has been important, especially in densely-populated areas like Kilimanjaro, Arusha, and Pare.

Mozambique has a very great undeveloped potential for irrigation on the basis of the Massengir Dam on the Limpopo, with estimates varying from 90,000 to 314,000 ha., and the Cabora Bassa Dam on the Zambezi in Tete Province,

where the potential is said to be more than 1 million ha. There also exists considerable further potential for irrigation in Zimbabwe. 19/

Exactly how much the development of large-scale irrigation schemes will be able to contribute to increasing the production of food in Africa is difficult to estimate. Costs are a formidable barrier; per-hectare-irrigated costs of U$5,000-US$6,000 are no longer unheard of. Other major factors influencing the calculation are the extent of the resources, both physical and financial, necessary for sustaining production once the initial investment has been made. (Commitments of foreign assistance have been received by interested governments for undertaking some of the large projects proposed, such as the Manantali Dam.) The future production decisions of the centralized agencies responsible for the management of these schemes also will affect the calculation.

Most of the large-scale irrigation schemes proposed in Sub-Saharan Africa are not situated in densely-populated areas; in fact, the ideal emplacement for a large dam, from the engineering point of view, may be an area that is practically uninhabitable (rock outcroppings, soils of little value to agriculture. This fact raises the question of where the labor is to come from to produce crops on an intensive scale. The record of the scheme of the Office du Niger (ably reviewed by De Wilde) shows that corvée (forced) labor had to be imported on a large scale, mainly from the Mossi Plateau, to fulfill the production potential of the scheme. If labor is drawn to new-irrigated areas from surrounding areas of dryland subsistence farming, the impact of the project on food security may not be altogether beneficial. 20/

Quite apart from the initial investment size, large-scale irrigation projects in Africa appear to be costly means of producing food. A survey of

centrally financed irrigation projects in Tanzania found none of them able to realize an internal rate of return of 10 percent. 21/ Even a relatively small-scale project like the Nianga Pilot Project on the Senegal River was recently found to be only marginally profitable with its existing crop mix of rice and tomatoes, and this is a project in which dryland farmers were converted to irrigated farming with the assistance of a full-scale extension effort by a semi-autonomous agency of the government of Senegal.

A nonmonetized cost of irrigation development is the snail-borne disease bilharzia, which spreads into new irrigation perimeters and preys on human beings, reducing labor productivity.

There is no reason to suspect that the management of large-scale irrigation projects will not be subject in the future to pressures to "upgrade" their output mix by replacing food crops with higher-value cash crops, as they have in the past. Such a course was advocated explicitly in one donor-financed project feasibility study in Senegal: "The crops chosen must, while meeting as quickly as possible the food requirements of the people of the Valley, generate high cash flows leading to rapid progress towards the stage of economic `take-off`" 22/ The net effect on total food production of this type of investment is thus far from clear.

Mixed Cropping

The growing of several different crops simultaneously in the same field is extremely common in Sub-Saharan Africa, both in the wet and in the dry areas.

In the rainforest areas, mixed cropping does the least damage, ecologically speaking, because the mixture of crops grown, each having a different growing season, keeps a protective ground cover on the soil year

round, preventing the erosion associated with bare tilled fields. Mixed cropping also helps to reduce the growth of weeds, and is labor-saving in this respect. Planting and harvesting labor requirements, on the other hand, are increased, but in such a manner as to distribute the labor demand over a longer period than with sole cropping. Generally speaking, mixed cropping takes a more highly skilled farmer than sole-crop farming.

Farmers obtain two advantages from this arrangement: the total output of the mixed-crop field is higher, other things being equal; and the diversity of crops acts as insurance against crop failure, thereby contributing to better stability of output over the years. The output effect is sometimes due to interaction among crops, as when a leguminous crop is planted alongside a cereal; pest-control effects have also been identified. Norman found that mixed cropping practiced in northern Nigeria resulted in higher gross returns per acre and per man-hour, on average, compared with single-crop stands, both over-all and in peak labor-demand season, in spite of lower yields for individual crops. 23/ In one village in his sample, 72 different crop combinations were identified.

The major disadvantage of mixed cropping is its incompatibility with many forms of mechanization, with herbicides, and with crop varieties requiring monocultures.

Serious research on mixed cropping methods is only now getting under way. Since they represent a relatively inexpensive way of intensifying food production, these methods should be further explored.

Labor

Micro-studies of African agriculture have identified labor as the scarce resource in production. In societies that have no shortage of land, the

amount of land planted by each household in any 1 year is often limited by the amount of labor available to that household. Labor shortages manifest themselves in the form of bottlenecks at specific times in the agricultural year coinciding with labor-intensive operations like field preparation, planting, weeding, and harvesting. Shortage of labor has been a constraint to large-scale agriculture as well as to smallholder production. 24/

In view of the importance of labor as a scarce input, it is a serious matter that there exist no data on labor utilization apart from case studies. Aggregating these data involves making extrapolations for ecologically similar zones and crops, producing inevitably a large margin of error, and no reliable time series whatsoever.

In the savanna areas, farmers know that their crop yields will be higher the earlier they get their seed in the ground. There is therefore a rush to plant at the first rain. Farmers have no way of knowing whether the first rain of the season indicates the arrival of the sustained rains of the monsoon, and so they often lose their first planting of seed when it turns out to be an isolated shower. Yet researchers in African agriculture often fail to take into account the fact that farmers must sometimes plant two or more times before being assured of getting a crop, and thus understate the total labor input.

At the other end of the production cycle, labor input does not end with the harvesting of the mature crop. Most food processing in Africa occurs at the household level, and this requires a large input, particularly by the women of the household. Therefore, sufficient labor must be available not

only to grow the crop and harvest it, but also to thresh it, dry it, shell it, grind it, or process it into butter or oil.

The supply of labor to agriculture in Africa is affected upwards by population growth and downwards by migration away from rural areas. The first has been extensively studied. The second seems to be a function of the differential between urban wage rates and the opportunity cost of labor in agriculture. In Senegal, for instance, the legal minimum wage rate has been 107 CFA francs an hour since 1974, while the opportunity cost of agricultural labor has been estimated at between 100 and 200 CFA francs per day, depending on the crop and the distance from the city. Superior social services in urban areas act as a further magnet.

The phenomenon of rural-urban migration experienced by many African countries has important implications for the food situation because it exerts a doubly negative effect: it deprives food production of scarce labor, and it adds to urban demand for food. Migrant labor moves both seasonally and for longer terms, and both within countries and across international borders. Examples of seasonal migration occur in Mali and Upper Volta toward Senegal and Ivory Coast, where migrants work on cash crops. Example of longer-term migration are Rwandans who seek employment in the mines of Zaire, and workers from many countries of Southern Africa who work in mines in South Africa.

Such migration has numerous side-effects. In Botswana, where many men are employed in South Africa, 40 percent of rural households are reported to be headed by women, a situation with obvious implications for the design of rural development projects. The income earned by migrants is an important source of cash to their families, raising purchasing power in rural areas.

A phenomenon of growing importance in labor supply is the existence of sizeable refugee populations in various parts of Africa. Examples are Chadians in Cameroon, Ethiopians in Somalia, Ugandans in Kenya and Sudan, Angolans in surrounding countries, and people from Zimbabwe in Mozambique and Zambia. Their total is now put at 2 to 4 million. These populations have an immediate influence on the demand for food, but they are also likely to become a factor in food supply to the extent that their settlement becomes permanent and they take part in production.

In conclusion, it may be postulated from what is known about labor supply in food production in Africa that it will continue to be subject to positive and negative influences, but that labor will remain a scarce factor of production until the gap between returns to labor in food production and in urban employment has been significantly narrowed.

Technological Change

Technology is the set of biological materials, implements, farming techniques and economic organization whereby inputs are combined to produce output in agriculture. Technological change is therefore a change in the technical coefficients relating inputs to output in the production function stemming from a change in one or more of these elements. 25/

Crop varieties (cereals, root crops, tree crops) in African agriculture have become adapted to their evironment over centuries. Their yields are relatively low by world standards, but they possess other characteristics which make them desirable. Cultivating, harvesting and processing implements are relatively simple and require a low level of energy use, other than human energy. Within the subsistence sector, which embraces the vast majority of

African farmers, the household is the basic decisionmaking unit and the techniques in use would appear to reflect the objective function of that unit, which is to produce a certain minimum for subsistence at least cost, and to avoid risks of food supply or economic failure.

African agriculture has probably been less affected by technological change in the past 20 years than agriculture on any other continent. In other parts of the world, new technology has entered the picture of agriculture production within this period, and, given the proper conditions, there is no reason to believe it will not enter the African scene to a much greater extent than it has at present. So far, African agriculture, in spite of wide geographical areas where crops, implements, techniques, and even organization forms, are broadly similar, has experienced nothing like the Green Revolution in Asia. When technological change comes to African agriculture, there is no guarantee that it will follow the same specific sequence as the Green Revolution. 26/

The following discussion reviews the present state and outlook for four major aspects of technology in Sub-Saharan Africa: (1) crop technology; (2) mechanical technology; (3) storage technology; and (4) food processing technology.

Crop Technology

Scientific collection and classification of varieties of African food crops dates back to the work of Portères in rice in the fifties. Major barriers exist to the development by plant breeders of new varieties of food crops on the basis of African genotypes and of genetic materials imported to the continent, and these will be reviewed later in this report. In part

because of these barriers, new crop technology has not been widely diffused in Sub-Saharan Africa.

Maize--Of all the staple crops in Africa, maize is probably the one where new technology, in the form of hybrid varieties 27/ that made their appearance in the 1960's, has had the greatest impact on crop yields and promises to have further impact in the decade ahead. The total area of maize planted in Africa reportedly approaches 18 million hectares.

Hybrid seed called H611, developed by plant breeders at the Kitale Research Station in Kenya, began to be diffused among farmers in 1964 and rapidly expanded in terms of acreage planted (table 27). Originally adopted

Table 27-- Kenya: Area of improved maize grown

Year	Large-scale farms	Small-scale farms	Total
		Hectares	
1963	158	4	162
1964	11,615	708	12,323
1965	22,137	8,110	30,247
1966	25,860	15,269	41,129
1967	55,501	46,642	102,143
1968	36,501	51,331	87,832
1969	39,500	64,291	103,791
1970	47,110	97,372	144,482
1971	63,785	149,864	213,649
1972	73,944	206,904	280,748
1973	53,370	264,699	318,069
1974	39,214	292,358	331,572
1975	50,697	352,053	402,750
1976	50,903	377,092	427,995
1977	59,357	429,602	488,959
1978	29,016	407,860	436,876
1979	20,146	347,550	367,196

Source: Data collected by F.M. Ndambuki, Maize Breeder, National Agriculture Research Station, Kitale, reported in AID, "Kitale Maize: The Limits of Success," Washington, D.C., December 1979, p. 31.

by large farmers, H611 spread to smallholders whose total output of hybrid maize soon outpaced that of the large farmers. Higher yields, plus the relative simplicity with which hybrid maize could be substituted for traditional varieties, reportedly accounted for its popularity. Yield superiority in field conditions with good husbandry practices amounted to 30 to 80 percent.

H611 was best adapted to the well-watered western highlands (climatic regions 1.7 and 2.3). Growers in the drier eastern regions of Kenya continued using the traditional varieties. Overall, by 1977, the Integrated Rural Survey of 1974-75 showed, 50 percent of Kenya's smallholders were growing hybrid maize and 86 percent were growing local varieties. 28/

From Kenya, hybrid maize spread into Tanzania, Uganda, and Zaire, both through official channels and private commerce. In Tanzania, aside from hybrids, the composite maizes Ukiriguru, Ilonga, and Kenya Katumani are in use; the first two are suited to medium to low altitudes, while the third is suited to low rainfall areas. Tanzania's National Maize Project distributes improved seeds along with inputs like fertilizer and pesticides.

A hybrid maize, SR52, was developed in Zimbabwe, which had a strong clientele for agricultural research composed of commercial producers, and is widely used today. In Zambia, SR52 has been widely adopted, by commercial producers. Initial yield increases were high, 50 to 55 90-kilogram bags per hectare, but now farmers blame insufficient control and monitoring of hybrid seed-producing farmers for their yields of 30 to 35 bags per hectare. SR52 is grown in Malawi as well, although Malawi has a relatively small large-scale

agricultural sector and most farmers plant traditional varieties selected year after year from the best of the previous season's crop; only about 8 percent of the farmers in the Lilongwe Land Development Project are reported to use improved maize varieties. UCA, a synthetic from Tanzania, is also grown to some extent in Malawi. Further south, improved varieties are grown in Swaziland and Lesotho.

In Zaire, synthetic varieties of white maize developed under the former INEAC 29/ program began to be diffused in the fifties under the GPS series. These undoubtedly had an effect in upgrading average yields. Presently GPS-5 is still widely grown, as is another synthetic, Shaba Safi. Two white synthetics developed from Central American genetic materials, Salongo (from Tuxpeno) and Kasai I (from Tuxpeno-Eto), have been tested with good results and are to be diffused under a project in Eastern Kasai financed by the World Bank. 30/ Yields of high-yielding varieties reported by the National Maize Project office in Gandajika range from 700 to 1,000 kg. per ha., compared with 400 to 600 kg. per ha. usually obtained with traditional varieties (although these yield as high as 1,000 kg. per ha. on the best land with the best agronomic practices. Preserving seed quality and distributing seeds to the farmer are believed to offer the best chance of increasing maize production in Zaire. As can be deduced from the names of the above varieties, most breeding work has taken place in the southern savanna; no information was obtained about maize in the northern savanna area.

Maize is grown in a wide belt of West Africa in the transitional zone between the forest and the savanna covering about 3.4 million ha. 31/ Almost everywhere it is grown as a rainfed crop. It is often intercropped. In

Ghana, where maize yields are higher than elsewhere, improved varieties include the Ghana composites 2 and 4, Golden Crystal, and La Posta. Estimated average yields for improved varieties are 1,500 kilograms per hectare. In Nigeria, the IITA-developed varieties TZB and TZPB are reportedly widely grown. A series of IRAT-developed varieties, denominated Z80, Z81, and Z85, are reported to have been tested with good results.

In his review of the state of plant breeding research for staple food crops in low-income countries, published in 1976, Cummings rates maize research as inadequate to seriously inadequate. 32/ Current responsibility for international research on maize in Africa lies with the International Institute of Tropical Agriculture (IITA), established in 1967 at Ibadan, Nigeria, in cooperation with the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. CIMMYT signed a 10-year agreement with Zaire in 1971, and has spent about US$1 million per year since then on its research program in Zaire.

Some more commonly grown high-yielding varieties of maize and other staple crops grown in African countries are shown in table 28.

Obstacles to diffusion of improved varieties include the logistical problems involved in distributing hybrid seed annually, adulteration of seed by farmers, unreliable fertilizer supplies, and storage problems. Among the latter may be cited the case of SR52, whose kernels are larger than those of traditional varieties, making ears outgrow the husks and exposing the kernels to insects and fungi when stored in the traditional bins. In Zambia, a new storage bin, called the Ferrumbu bin, has been developed to meet this problem. There is also a taste preference for traditional varieties. In

Table 28--Improved crop varieties grown in Sub-Saharan Africa

Crop and variety	Country where grown
Maize:	
H611	Kenya
Ukiriguru	Tanzania
Ilonga	Tanzania
Kenya Katumani	Tanzania
SR52	Zimbabwe, Zambia, Malawi
GPS-5	Zaire
Shaba Safi	Zaire
Salongo	Zaire
Kasai I	Zaire
UCA	Malawi
TZB	Nigeria
TZPB	Nigeria
Z80, Z81, Z85	West Africa
Ghana Composites 2 and 4	Ghana
Golden Crystal	Ghana
La Posta	Ghana
Millet:	
P3 Kolo	Niger
Sorghum:	
Serena	Tanzania
Lulu	Tanzania
SK5912	Nigeria
Rice:	
Makalioka 34	Madagascar
Vary Lava Marovoay 47	Madagascar
Ali Combo	Madagascar
Boina 1329	Madagascar
RS 25T	Madagascar
Chianan 8	Madagascar
IRAT 10	West Africa
SE 302G	Senegal
Iguape Catgeto	West Africa
OS-6	West Africa
IRS, IR8, IR20	Various

Source: Various reports.

Zaire, farmers say the improved varieties are less insect-resistant in post-harvest storage.

Millet--Millet is widespread in Africa and is grown in an area of about 11.5 million ha. in West Africa alone. It is well adapted to the savanna zone and, as the most drought-resistant major crop, can be counted upon to provide a minimal yield even in very bad years. 33/ The varieties traditionally grown on the desert edge have maturity periods as short as 55-65 days. Millet does well on light, sandy soils. Yields get progressively higher as one moves away from the desert and the growing season lengthens. But millets cannot tolerate waterlogging.

No technological breakthrough has occurred in breeding millet varieties, and Cummings rates the state of research on the crop as seriously to critically inadequate. The longest-standing research program has been conducted by the Institut de Recherches Agronomiques Tropicales (IRAT). The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), at Hyderabad, India, has had millet research as one of its mandates from its establishment in 1972. ICRISAT has established research facilities and maintains personnel in Africa. Plant breeders found, however, that millet genetic materials from India did not do well in Africa, with severe genetic erosion taking place. They concluded that no direct transfer of plant material was possible, and that conversion work had to be done in situ. This is barely getting started (work in northern Nigeria has been in progress for about four years), since ICRISAT's headquarters for millet research in Africa, planned for Niamey, has not yet even been built.

Such improved varieties of millet as have become available so far in West Africa have given poor results. A recent AID assessment of a package based on

the improved variety P3 Kolo in Niger had this to say: "The technical package, applied uniformly through Niger`s geographical regions, has yet to be proven consistently superior, during the best of rainfall years, to Nigérien farming techniques."

The magnitude of the task ahead can be judged from the fact that ICRISAT has not yet even been in a position to recommend a specific millet technology package for the red soil areas of India. The African soils where millet is grown are understood even less well, with scientists only now becoming aware of the complexity of the erosion problem.

Sorghum--Sorghum is grown over an area of about 9.7 million ha. in West Africa alone, where it is well adapted to a wide range of soil and rainfall conditions. Sorghum, like millet, is native to Africa. 34/

Traditional varieties are reported to perform in a manner that is closely tied to local conditions, especially the date of the end of the rains. Sorghum varieties are photoperiodic, and seed set occurs as the weather becomes dry, a feature that reduces spoilage from molds and insects. The growth cycles of local sorghum varieties in West Africa range from 120-135 days in the north to 240 days in the south without losing their dry-weather seed set feature. The disadvantage is that local varieties cannot be displaced north or south.

Two improved varieties of sorghum are reported to be grown in Tanzania. They are Serena, a red, and Lulu, a white sorghum. A short-stalk improved variety, SK 5912, is grown in northern Nigeria.

Sorghum research is carried on by IRAT and ICRISAT, whose research unit for sorghum is located at Ouagadougou. No technological breakthrough has occurred. Cummings rates the state of research as seriously inadequate.

Rice--The situation with respect to rice, the fourth ranking crop in Sub-Saharan Africa in terms of acreage after maize, millet, and sorghum, is more hopeful. The pioneering work of Portères in collecting and classifying has been mentioned. Two species of rice are grown in Africa: *Oryza sativa*, which was imported from Asia; and *Oryza glaberrima*, which was domesticated in West Africa 3,500 years ago. 35/

For purposes of analyzing food production, a more practical classification of types of cultivation is needed for a crop that is grown in a wide range of conditions. This report adopts the classification scheme proposed by the West Africa Rice Development Association (WARDA), an intergovernmental organization comprising 15 states of West Africa. The classification, together with an estimate of the area in West Africa covered by each type of cultivation, is given in table 29. It is reasonable to assume that types of cultivation in Madagascar, Africa's single largest rice production nation, and elsewhere outside West Africa, fall into this classification scheme as well.

This classification eschews the term irrigation, which is susceptible to confusion. In the strict sense of the term used in this report, irrigated production, meaning production under full water control, covers only an estimated 2 percent of the rice-growing area in West Africa, or slightly more than 40,000 ha. out of an estimated total of 2,300,000 ha. A brief description of the types of cultivation, with their main locations, follows.

Upland rice cultivation (1) is defined as cultivation on land not subject to flooding where no water level covers the soil throughout the cultivation cycle, apart from exceptional circumstances and for a very limited period. This class is also sometimes called dryland cultivation.

Table 29-- Types and area of rice cultivation in West Africa, 1978

Code	Type	Percentage of total area
	Total	100.0
1	Upland rice cultivation	65.0
11	Strictly upland cultivation	52.5
111	Hill rice	5.0
112	Flatland rice	57.5
12	Groundwater cultivation with rains	2.0
13	Groundwater cultivation with out rains	.5
2	Lowland rice cultivation	35.0
21	Mangrove rice cultivation	8.0
211	Without tidal control	2.0
212	With tidal control	6.0
22	Freshwater cultivation	27.0
221	Without water control	22.0
222	With partial water control	3.0
223	With complete water control	2.0

Source: West Africa Rice Development Association, "Classification of Types of Rice Cultivation in West Africa," mimeo 1978, p. 20.

Strictly upland cultivation (11) is practiced on well-drained land not subject to flooding, where rain is the only source of water. Therefore, it is only feasible in areas where total rainfall and its distribution meet the requirements of rice throughout its vegetative cycle. Hill rice (111) is grown under shifting cultivation in Sierra Leone and Liberia and in the Abengourou, Man, and Touba areas of Ivory Coast. Flatland rice (112) is grown on gently sloping land and is the main form of cultivation in West Africa, predominating in Liberia, Sierra Leone, and in the forest zones of Ivory Coast, Ghana, and Nigeria. It is also grown in the humid fringe of the savanna in Guinea Bissau, Gambia, southern Senegal, southern Mali, southern

Upper Volta, and in the northern parts of Ivory Coast, Ghana, Togo, Benin, and Nigeria.

Groundwater cultivation with rains (12) is defined as cultivation which draws its water supply partly from rain and partly from shallow groundwater, usually at the foot of slopes or on hydromorphic soils. Systematic production of this type occurs in the Casamance and eastern regions of Senegal. Groundwater cultivation without rains (13) is practiced only on some lakes in northern Mali whose soils show great capilarity.

In contrast to upland cultivation, lowland cultivation (2) covers all types of rice cultivation where the soil is submerged to a major or minor degree during a considerable part of the vegetative cycle. This group includes many types which differ in the depth of water on the field, the degree of water control, quality of water, and other respects. A first type, mangrove rice cultivation (21), is practiced on land generally cleared of mangrove forest. This may be without tidal control (211), as in Senegal and Gambia, or with tidal control (212), a more important variant in which dykes help protect the land (polders) against seawater. The latter is found in the following areas: Guinea Bissau (90,000 ha.), Guinea (40,000 ha.), Sierra Leone (25,000 ha.). Gambia, (10,000 ha.), Senegal (10,000 ha.), and Nigeria (5,000 ha.).

In freshwater cultivation (22), the most important criterion is the degree of water control. In the type without water control (221), the field is submerged by rain or from a stream without the presence of any facilities to offset a supply deficit or to drain the field. This type is widespread in West Africa and even extends to the Selibaby swamps of Mauritania where

rainfall is 600 mm. in a good year. Also known as bottomland cultivation, it covers the fadama system of Nigeria and the boliland system of Sierra Leone, as well as the floating rice cultivation of the inland delta of the Niger River in Mali.

Freshwater cultivation with partial water control (222) implies an infrastructure of canals or channels connected to a dam or pumping station. Full water control is not achieved in this type because in general the large size of the fields, inadequate leveling of land, and limited drainage capacity all make it impossible to maintain optimum water depth throughout the field and to drain it at theright moment. In West Africa, this type is found mainly in the old irrigated perimeters of Mali (40,000 ha. of the Office du Niger) and Senegal (6,000 ha. of the Richard-Toll perimeter) which were built at a time when the state of rice-breeding technology did not justify the extra costs of assuring full water control.

Complete water control (223) is a recent type of rice cultivation in West Africa and exists at the present time on only about 15,000 ha. in Ivory Coast, 10,000 ha. in Senegal, 1,000 ha. at the M`Pourié perimeter in Mauritania where a Chinese technical assistance mission has been working, and elsewhere. Projects to assure this type of cultivation are under way in Nigeria and Mali, where the World Bank is financing rehabilitation of 1,500 ha. of the Office du Niger.

Research on rice in Africa dates back at least to 1927, when the Marovoay Agricultural Station in northwest Madagascar began selecting panicles from local varieties grown by farmers for pedigree breeding. Later on, the Alaotra Lake Station also began work. 36/ High-yielding varieties were developed that

are still grown today, namely Makalioka 34 (50,000 ha.), Vary Lava Marovoay 47, Ali Combo, Boina 1329, and RS 25T.

The major technological constraints on upland rice cultivation have been the prevalence of blast disease; the fact that the well-drained soils of the high-rainfall areas where this type occurs are often leached and have poor water retention capacity, making the crop susceptible to water stress if a few days of drought occurs at a critical phase of growth; the presence of toxic elements (aluminum and manganese) in the soil; and heavy weed infestation problems arising from the absence of transplanting or submersion.

Rice breeders at the French IRAT (Institut de Recherches Agronomiques Tropicales) station at Bouaké, Ivory Coast, have developed and released a dwarf rice variety (IRAT 10) which overcomes most of these problms and has given yields as high as 4MT ha. on station and more than 3 MT/ha. on farmer`s fields with fertilization in trials in Casamance. This is a short-cycle (100 days) rice.

The Sefa research station in Casamance released a dwarf variety of upland rice (SE 302G) 7 years ago which did well, but has become susceptible to blast. Researchers in West Africa are finding out that new strains of blast develop as rapidly as rice varieties resistant to old strains of the disease appear, leading them to conclude that only a continuing process of breeding will overcome the problem.

Improved varieties of upland rice from Brazil (Iguape Cateto and OS-6) are also grown in West Africa. Several improved varieties identified from WARDA-coordinated trials in West Africa are listed in an IITA publication. 37/

With respect to lowland rice cultivation, the incomplete degree of water control has hampered the diffusion of dwarf varieties. The differences of

level within plots (up to 50 cm.) prevent transplanting and force the farmer to delay submersion of the field, which makes weed control difficult. Inadequate levelling also forces the farmer to maintain deep water in the low-lying parts of his field, compelling him to plant long-stemmed varieties that may lodge. These problems prevent high rates of fertilizer application, holding yields down to the 1.5 to 2.5 MT/ha. range. Nevertheless, tall rice varieties in the Office du Niger have recorded yields as high as 6 MT/ha. 38/

The introduction of high-yielding sativa rices from Asia into Africa has been constrained mainly by the susceptibility of these varieties to blast. The most widespread Asian introduction, Chianan 8 from Taiwan, is reportedly grown on 30,000 ha. in Madagascar. Some IR5, IR8, and IR20 seed has also been introduced in places.

Cummings rates the state of rice research in Africa as inadequate. There has been some recent evidence, however that WARDA intends to coordinate the work of the national research organizations and give them greater direction than they have had in the past. In this connection, the IRAT station at Bouaké, with two substations for the monomodal and bimodal rainfall areas, has been declared the main regional station in West Africa for research on upland rice; a station at Mopti is to be the regional station for floating rice; one at Rokupr in Sierra Leone for mangrove rice; and one at Richard-Toll for water-controlled rice.

Rice in Africa is grown mainly as a subsistence crop. The rice production of the Casamance region of Senegal, of the coastal West African countries, of Cameroon, and of Madagascar, goes mainly to feeding the producing population. Long-grain Casamance rice, for instance, hardly enters the Dakar market 150

miles to the north where an acquired taste for high percent broken Asian rice, which is short-grain, predominates. The same holds true for Cameroon.

Wheat--Wheat must rank as a minor crop in Africa, covering less than 1.5 million hectares in the tropics. The only important producers are Ethiopia; Sudan, where the crop is grown on irrigated land in the Gezira; Kenya; Tanzania; Lesotho; and Zimbabwe (irrigated). Dalrymple in his survey found that high-yielding varieties of wheat have found a modest foothold in these countries, accounting for the highest proportions of area probably in Sudan, Kenya, Tanzania and Zimbabwe. 39/ Two of the agricultural research stations that have been involved in the spread of the high-yielding varieties are the Njoro Station in Kenya and the Lyamungu Research Station in Tanzania. An attempt to introduce wheat production at Lake Chad ran into serious human problems. 40/

Roots and Tubers--Root crops and tubers constitute an important element of the diet of much of Sub-Saharan Africa, particularly the forest areas, accounting for more than half the calories in the diets of Zaire, Congo, and Gabon. Some upgrading of cassava varieties has occurred. Mosaic disease remains a major stumbling block. Although IITA has been engaged in research on cassava, yam, sweet potato, and cocoyam improvement, no promising new technology has as yet been developed. In the search for a high-yielding variety of cassava, IITA has established a breeding program which is expected to produce clones for farm-level testing and farmer evaluation after 5 years. 41/

Bananas and Plantains -- Bananas are also an important food in Sub-Saharan Africa. Here also no new technology has been developed.

Mechanical Technology

After some initial, discouraging experiences in attempting to upgrade their mechanical technology in agricultural production through tractorization (e.g. Tanzania), 42/ some African governments have come to see small-scale mechanization as being a more rational course for increasing food production in conditions of foreign exchange scarcity. The sharp rise in fuel costs that has occurred since 1973 has only served to reinforce this focus of interest.

Although the costs of small-scale mechanization are considerably lower than tractorization (even when the latter receives an implicit subsidy in the form of overvalued currencies), the picture is not altogether encouraging. Animal traction, the logical intermediate step between the technique of the hand hoe and machete and the tractor, has been adopted only here and there.

In some areas, animal traction is ruled out by trypanosomiasis, until successful and economic control methods are found and applied. Trypanosomes carried by the tse-tse fly make livestock raising either hazardous or impossible. East coast fever is another serious disease of livestock in Africa. Control of these two diseases is the initial goal of the International Laboratory for Research on Animal Diseases (ILRAD), located in Kenya.

In tse-tse fly-free areas of the continent, a number of other obstacles to adoption of animal traction have been identified. These have been broadly classified as follows:

--Difficulties of the natural environment (scarcity of forage in dry season, need for destumping fields, soil problems);

--Difficulties of the social environment (cultural resistance to keeping cattle);

--An unfavorable relationship between cash costs and returns;

--Problems associated with the delivery and reimbursement of inputs;

--Labor bottlenecks. 43/

In sum, it appears that although agricultural development projects based on animal traction have been attempted in almost every African country, there has been differential adoption across ecological zones, socioeconomic forms of organization, and crops. The reasons for this are as yet little understood.

Storage Technology

This aspect of technological development consists of two parts: on-farm storage technology and centralized storage technology.

On-farm storage of staple cereals, roots and tubers is very important to the livelihood of African farmers. In the monsoon areas it allows them to tide over their food supply from one cropping season to the next, and to cope with the effects of a bad year. This helps explain the relatively great effort and expense that go into construction of storehouses, and the relatively large quantities of grain held in on-farm storage. Storage problems become more acute in heavier rainfall areas; in the latter, however, roots and tubers may be kept in the ground until needed for consumption. The roots and tubers do lose weight and nutrients, however. Stored food constitutes an important form of savings, readily convertible to cash when required.

The technology of crop storage has made some advances in its differing on-farm and centralized forms. In the case of the former, there have been several demonstrations of applying local materials (such as mud bricks) and simple construction techniques to improve traditional methods of preserving

staple foods from the depradations of the elements, birds, and insects. The cost of construction has in some instances been brought down to the range of $25 per ton of storage capacity. The technology of centralized storage has advanced well beyond the ability of governments to finance acquisition and maintenance of reserve stocks, and to manage them.

Processing Technology

Food processing in Africa takes place under a wide range of technologies. The processing of rice, for instance, ranges from the housewife hulling rice with a wooden pounder in her farm yard (capacity about 5 to 6 tons per year) all the way to the modern industrial rice mill in the city (capacity about 30,000 tons per year). There is great scope for improvement of processing technology within this range, and for several crops.

Other Inputs

Fertilizer

Fertilizer use in Africa is skewed two ways. First there is heavy concentration of the use of fertilizers in the large-scale farming sector, where governments control supplies (either domestically manufactured or imported) or managers of large commercial farms can usually arrange to secure such supplies. Secondly, fertilizer use is skewed with respect to crops in the direction of cash crops. This last is partly a result of the role para-statal agencies have traditionally played in providing farmers with fertilizer on credit for the production of cash crops.

In the subsistence sector, little use is made of chemical fertilizers. Crop fields nearest the house often receive the benefit of manure from animals and household wastes, the effect of which is to counter slightly the decline

in fertility due to continuous cropping. Thus, the staple cereals millet and sorghum are grown practically without fertilizer throughout the continent although traditional varieties have shown increases in yields even at low levels of fertilization. The diffusion of hybrid maize, on the other hand, has entailed some use of fertilizer, as have improved rice varieties. At higher levels of fertilizer use, water and fertilizer become complementary, and use of the one without the other risks damaging the crop by "burning".

Some results of demonstrations carried out under the FAO Fertilizer Program are given in table 30.

A few African countries possess their own fertilizer production capacity. Senegal and Tanzania are among these. The experience of the Tanga fertilizer factory in Tanzania 44/ leads one to conclude that indigenous manufacture is costlier than importing if the manufacturing process depends on imported raw materials to any great extent. However, most African governments would probably not want to place an increase in agricultural productivity altogether at the mercy of supplies of fertilizer whose dates of delivery and prices could not be guaranteed. Nigeria and Gabon, because of oil production, would appear to be in a position to manufacture large amounts of fertilizer. There is as yet no valid estimate of demand for fertilizer in Nigeria. 45/ Internal distribution poses a major problem for African countries.

Pesticides

An estimated 15 to 25 percent of total crop production in Africa is lost in the field and another 15 to 20 percent is lost in storage due to pest damage. Even if these estimates are high, the loss from pest problem is unquestionably high, depriving Africa of food it already produces. The loss rates vary widely among crops and production and storage conditions.

Table 30--Yield response to fertilizer, selected Sub-Saharan countries

Region, country and crop	Fertilizer demonstrations	Yield: Without Fertilizer	Yield: With fertilizer
	Number	Metric tons/ha.	
Sahel:			
Senegal--			
Millet	901	0.52	0.80
Rice	379	1.13	1.63
West Africa:			
Ghana--			
Maize	2,661	1.27	1.89
Yams	592	8.04	11.49
Nigeria--			
Maize	4,905	1.45	2.01
Cassava	337	11.70	16.00
Sierra Leone--			
Upland rice	646	.93	1.51
Lowland rice	612	1.63	2.43
East Africa:			
Ethiopia--			
Teff	687	.77	1.64
Wheat	571	.93	1.81
Kenya--			
Maize	862	3.11	4.92
Southern Africa:			
Botswana--			
Sorghum	87	.58	.92

Source: Food and Agriculture Organization, FAO Fertilizer Programme: The First Decade (Nov. 1974).

Pesticides are presently used in most countries, but primarily on cash crops such as cotton, cocoa, and coffee. Chemical pesticides are easily available from multinational petro-chemical companies which distribute their products through their own channels or with the assistance of government agents. But because of the cost, the health hazards involved, and the level

of education required for their proper use, chemical pesticides are impractical and inappropriate for use on food crops by most African farmers. Research is thus being undertaken on "integrated" methods of pest management, that place a premium on natural controls such as encouraging already present pest predators, breeding of pest and disease resistant plant varieties and employing specific crop rotation and soil management techniques that decrease pest population. Low-cost, easily employable methods of plant protection will have to be introduced if losses in production are to be decreased.

Herbicides

Herbicides are hardly used in Africa outside the cash crop sector. One reason for this, apart from their cost, is that they are incompatible with mixed cropping. There is also some debate over the value of herbicides in areas where the rainy season is very short and soils are low in organic matter. It is traditional in such areas for weeds collected in mounds to provide the location on which crops in the following year will be planted. Thus, the introduction of herbicides in such areas may result in a short-term benefit that has a long-run cost due to ever-decreasing organic matter in the soil.

Training and Extension

Most African countries do not possess trained agriculturalists capable of administering government programs to improve the productivity of farmers. With a few exceptions, these countries are not steering secondary school students into agricultural careers with the aim of creating such a body of trainees. A recent report on the agricultural sector in Niger estimates the shortfall in trained manpower in agriculture in 1982 at 61 percent even under

the most optimistic assumptions. Niger currently has one extension agent for every 2,500 to 3,000 farmers.

Besides being spread thinly on the ground, the extension services of most African countries are seriously overburdened with a multiplicity of responsibilities. Typically, the extension service is asked to implement every new agricultural development scheme emanating from the ministries in the capital. As a result, extension agents in the field have to make a choice of which programs to devote their time and efforts to, and which ones to ignore, and often their ranking of priorities in making this choice does not correspond to the priorities of the central government.

The poor state of the extension services in Africa is not a serious constraint on increased productivity so long as there are not "packages" of viable cultural practices and/or new technology, together with supplies of inputs to back them up. Once these packages do exist, however, and farmers gain the expectation of being able to share in their demonstrated profitability, the poor state of the extension services may foreseeably become a major constraint, if not the major constraint, on closing the gap between present and potential productivity.

Reasons for Absence of Green Revolution

Looking back over the last 15 years, we see that food production in Sub-Saharan Africa has been increasing at an annual rate of 1.8 percent. The production data indicate increases in production of maize in countries where hybrids and synthetics have been adopted, 46/ with yields stagnant elsewhere; stagnant or declining production of millet and sorghum; a gradual rise in rice production; 47/ and stagnant or declining production of roots and tubers.

Most of the increase that has occurred can be attributed to an expansion of area planted, a lesser portion to higher yields. 48/

In no country in Sub-Saharan Africa, even Kenya, has there been a clearly visible departure from the production trend line that could be attributed to the adoption of a package of inputs based on new technology. This absence of a Green Revolution in Africa might at first seem puzzling, and warrants a look back at what happened in Asia in the 1960's.

The Green Revolution was made possible by a favorable set of circumstances. These included an infrastructure for and experience in the use of irrigation, which, more than anything else, distinguished the areas where it took hold from those where it did not; a major breakthrough by plant breeders who developed high-yielding varieties of rice and wheat capable of being grown over the wide areas where water and fertilizer supplies were assured; and a commercialized system of agriculture linked to markets by relatively good transportation networks.

In Africa, the aggregate irrigated area is a relatively small, but by no means insignificant, part of total cropland. Nothing like the large-scale development of water resources that took place in Asia in the fifties and Sixties appears possible. In Asia, where dams and canals could not carry water, cropland was irrigated from dependable, often shallow, aquifers by means of tubewells. In contrast, the geology of much of the African continent makes water control difficult to achieve by any method

In the irrigated areas in Africa improved varieties of rice and wheat are grown, including high-yielding wheats. But high-yielding rice varieties from Asia are almost totally excluded from Africa because of plant disease,

especially blast. In sum, the direct transfer of Green Revolution technology to Africa has had no appreciable impact.

Most agriculture in Africa is rainfed, meaning water control is not assured. The problem of breeding new crop varieties--millet, sorghum, maize, upland rice and wheat--for production under rainfed conditions in Africa is more complex. Critical factors affecting plant development, yield, and resistance to diseases and pests such as length and intensity of rainy season, intensity of solar radiation, and soils are much more variable in the area of rainfed agriculture in Africa than they are in the irrigated, Green Revolution areas of Asia. From the plant breeder's point of view, this multiplies enormously the number of "target" environments for which to crop varieties.

Even the diffusion of hybrid maize, one example of a successful plant breeding effort in Africa, has been geographically limited by the ecological zones to which specific varieties are adapted.

The conditions in which rainfed agricultural production takes place in Africa would appear to limit substantially the maximum yields to be expected from new crop varieties. Not only must these varieties be both resistant to drought and to the diseases of the rainy season in which they are grown, but their maximum yields are limited by the fact that the cloudy skies of the tropical monsoon reduce the amount of sunlight reaching the plants, impairing photosynthesis.

The adaptability of the high-yielding varieties of rice developed in the sixties by IRRI to large areas of Asia stemmed from the fact that these new varieties were largely insensitive to photoperiod. If plant breeders were able to incorporate this genetic character into new varieties of sorghum in Africa, for instance, soil and rainfall conditions would permit these new

varieties to be produced over similarly wide areas, with considerable impact on total production.

A whole new set of problems of adaptability--the degree to which a new variety is sensitive to environmental differences across locations--attaches to the variability of cultural practices common to African agriculture. Whereas the Green Revolution took place in monocultures which were relatively simple input-output systems, farming in Africa often involves growing mixtures of different crops grown in the same field, using variable allocations of family labor, both specific to a particular region.

In addition to adaptability, the problem of stability--the degree to which a new variety is sensitive to changes in environment over time in the same location--is severe in rainfed agriculture areas of Africa. This results from the extreme variability of rainfall from one year to the next in many ecological zones.

Lastly, an important contributory factor to the success of the Green Revolution in Asia was the existence of good networks of roads, over which supplies of inputs were delivered to district levels and thence distributed to farmers by oxcart, and output was channeled to markets. In Africa, by contrast; rural road networks are poor to non-existent, and cannot be relied upon to provide these vital links.

Production Relationships and Implications for Increasing Food Output

In reviewing the resources available for increasing food production in Sub-Saharan Africa, it has been pointed out that the scarce factor of production is in general labor, and that this scarcity manifests itself in the form of bottlenecks in agricultural operations. Time after time, shortage of

labor is pointed to in macro-economic surveys of country agriculture in Africa to explain the failure of technically sound agricultural projects to generate the intended returns. This statement holds true for both dryland and irrigated agriculture projects, with the situation becoming especially marked in the case of the labor-intensive crop lowland rice. From micro-studies it is clear that when cultivation of irrigated cash crops competes for labor with cultivation of dryland subsistence crops, farmers are willing to abandon the irrigated crop, even though the economic return to labor may be greater in the latter. 49/

The implications of the labor-scarcity of African agriculture follow from economic theory. Since productivity is measured by normalizing on the scarce factor of production, measuring output per man-hour becomes more meaningful than measuring output per hectare. Planners should be looking for ways to maximize the return to labor. If production of a subsistence crop is a priority, raising the productivity to subsistence crop labor will allow producers to devote more time to cash crops.

The productivity of labor in African agriculture can be increased by the introduction of labor-augmenting technology, in the same manner as the productivity of Asian agriculture was increased by the introduction of land-augmenting technology (such as technology which allowed intensification of production through multiple cropping). Labor-augmenting technology allows the same output to be produced with less labor, or alternatively a greater output to be produced with unchanged labor input.

Labor-augmenting technology is usually, but not always, mechanical technology. Herbicides are also labor-augmenting in their effect. Crop technology which increases yields, hence increases weeding and harvesting

labor requirement while leaving planting labor requirement unchanged, will in fact be labor-augmenting if labor availability is most constrained in the planting operation. The close correlation between mechanization and labor productivity in African conditions has been empirically demonstrated, as shown by the data in table 31, drawn from farm survey results in Sine Saloum, Senegal. The effect of labor-augmenting technology on land input is that, so long as land input is unconstrained, other things being equal, it will allow acreage per worker to expand, or if land input is constrained, it will allow greater output per hectare.

A serious obstacle to the adoption of labor-augmenting technology in African agriculture is its cost, both in terms of cash investment and in terms of labor time. It is generally realized that mechanical apparatus, even of a fairly primitive type, costs several times as much as traditional tools for the same purpose. This is particularly so if the calculation encompasses not only investment in draft animals but also their upkeep (a cost, again, that may be figured in money terms or in labor time spent in producing forage for dry-season feeding). That mechanical technology does not reduce labor time, but in fact actually increases it, has been demonstrated.

The French extension firm SATEC, for example, had little success in the Mossi Plateau with propagating a technological package that required a labor input of 6 to 7.5 man-days per ha. for soil preparation alone in an area where traditional hand implements required only 6 to 7 man-days per ha. for soil preparation and sowing combined. In the peanut basin of Senegal, on the other hand, SATEC had enormous success in diffusing a package involving animal traction that reduced labor input from 60 hours per ha. to 16 hours per ha. for sowing, and from 190 hours per ha. to 90 hours per ha. for weeding.

Table 31--Productivity in peanut cropping, Sine Saloum, Senegal

Sex of worker	Household identification number	Private plots	Average size of private plots	Average degree of mechanization	Average gross output	Productivity/ worker-hour
		Number	Hectares	Percent	Index	Index
Male	4b	1	0.65	5.7	100	100
	2	1	.66	5.0	158	189
	1	4	.53	4.7	128	152
	4a	2	.77	6.4	300	308
	5	4	.97	14.2	523	547
Female	2	2	.13	0	100	100
	1	3	.43	0.3	202	196
	4b	3	.35	2.4	215	220
	4a	3	.54	5.5	422	456
	5	3	.35	6.3	349	672

Note: The coefficient of correlation between the average degree of mechanization and productivity per worker-hour has the following values: male workers = 0.9184; female workers = 0.9492. (USDA/ESCS calculation)

Source: Data from Paul Kleene, "Notion d'Exploitation Agricole et Modernisation en Milieu Wolof Saloum (Sénégal)," L'Agronomie Tropicale, XXXI, pp. 63-82.

A major bottleneck (that is, a serious deficiency of labor input availability relative to labor input requirement for a particular operation) may not always be as large a constraint on output as a smaller bottleneck situated at a more sensitive time in the crop cycle. Thus, for example, labor may be lacking to harvest the crop, but the predicament can be overcome by lengthening the period of harvest labor input, since the weather has turned dry by then and little output loss is risked. On the other hand, a smaller bottleneck (that is, a minor deficiency of labor input) occurring at the beginning of the crop cycle can result in serious output loss in terms of lower yield due to late planting.

Farmers have various means of breaking bottlenecks in production. They have been shown to work longer hours per day in peak labor demand periods, and to work more days in production during such periods, giving up otherwise slack time and other occupations. For subsistence farmers in the dry areas, however, the greater effort comes just at the time of year when food gets short and diet consequently may be suffering. Another means farmers have of breaking bottlenecks is to hire labor. Here again, however, in view of the small extent of household savings in general, the peak labor demand often coincides with the period of the year when the household has little to sell and cash is lacking with which to pay hired labor.

Norman has pointed out that labor markets in Africa are usually imperfect: there is often no substantial monthly variation in wage rates, although there is obviously a great deal of variation in the marginal productivity of labor. For example, in northern Nigeria the marginal productivity of labor at critical bottlenecks periods was found to be up to four times higher than the wage rate.

The introduction of new technology will usually shift labor bottlenecks, reducing some but accentuating others.

Enger has recently compiled field data for AID comparing the labor input requirements of traditional and mechanized techniques of growing millet and sorghum in Niger. 50/ Enger's data indicate a modest 21-percent average higher requirement in labor input per hectare for all operations using a mechanical technique, but a 50-percent average higher requirement for the early operations, consisting of land preparation, phosphate spreading (absent from the traditional technique), row marking (likewise absent), and seeding. This represents a risk of lower yields, and implies that it stands in jeopardy of being a failure so far as farmers are concerned.

A new package based on mechanical technology that merely shifts a bottleneck from one critical part of the crop cycle to another will probably not be viable. But if it shifts it from a critical time to a non-critical time, it will be viable.

In the comparative maize production systems studied by Norman and others in northern Nigeria, the peak demand for labor in the traditional system occurred in June and July at weeding time. But the substitution of animal traction for some of the hand labor in this period shifted the peak labor demand to October, when harvesting the higher output of the improved variety maize created a bottleneck. This last bottleneck was not critical, since timeliness of harvesting was not an important factor in determining yield. 51/ (This does not take into account field losses to birds, which may be high).

Animal traction in and of itself, however, may create a new bottleneck. Animals require closer supervision while grazing during the rainy season

because of standing crops in the fields. This implies more work for the household, and even adult members, during the cropping season.

With or without new mechanical technology, raising the productivity of the subsistence sector in African agriculture depends heavily on improving agronomic practices by whatever means available. Factors such as time of planting, depth of planting, spacing of plants, and so forth have all proven to be extremely important in determining crop yields. At the same time, there is a promise that innovative systems of mixed cropping will help arrest the decline of soil fertility. The improvement of agronomic practices, however, implies a major commitment of financial resources to upgrading extension services on the part of African governments and a higher social status for extension workers, which in the face of urbanization of elites is likely to prove unattainable.

The implication of what has gone before in this section is that to raise the productivity of the subsistence sector in African agriculture requires a "package" of new technology and appropriate inputs which up to now has not been forthcoming. The Green Revolution in Asia resulted from just such a package, consisting basically of new crop technology, controlled water, and fertilizer. The different conplexion of factor scarcities in Africa, however, makes the diffusion of an eventual (presently nonexistent) package more difficult.

The land-augmenting package of the Green Revolution, based on crop technology, affected first the utilization of the scarce factor, land. Adjustments in labor utilization followed suit, once the visible benefits of the package were known. In the African case, the first adjustment to be made

to application of an eventual "Black Revolution" package must come in the form of labor utilization. This means adjusting total hours of labor and their distribution, that is to say work patterns. There will be an impact on use of family labor and living patterns.

There is likely to be a premium on incentives attached to the higher output per man-hour resulting from the new package. Government extension programs and credit programs, and adult literacy campaigns and programs not normally thought of in the context of inputs into production are likely to have a high payoff.

A hopeful sign is that donor agencies, research institutes, and researchers generally are increasingly turning their attention to what has come to be known as farming systems research. This is research into not only the technology of individual crops or individual machines, but also the way in which these interact with farming practices to produce the coherent whole that is the picture of the subsistence sector with its various inputs and outputs, its seasonal, and its year-to-year fluctuations.

The road of farming systems research will necessarily be a long one and results cannot be expected quickly. In India, for instance, where the data base is much firmer, ICRISAT has not yet even reached the stage of evolving the methodology for tailoring a technological package to fit the site-specific requirements, and is consequently still following the inordinately long method of trial and error. The evolution of such methodology should be high on the priority list for research on African agriculture.

Rethinking Research Methodology

The whole question of research methodology for food production in Sub-Saharan Africa needs to be rethought. The scattershot approach to finding

solutions to real problems has produced no significant results in farmers' fields for a painfully long period of time, while food gaps in African countries have grown larger. A new approach to agricultural research incorporating a strong sense of direction is badly needed.

In view of what has been said about the physical and human environment of African agriculture in this report, it should come as little surprise that Africa and Asia have fared so differently in the relative values of the contributions made by developed countries to their agricultural development.

In the field of crop technology, the international agricultural research centers created on the initiative of the developed countries focused on the development of high-yielding varieties of wheat and rice that were adaptable over wide areas of irrigated production in Asia. The same crop-specific approach to the plant technology problem in Africa led to the establishment of ICRISAT to work on millet and sorghum and IITA to work on maize, rice, legumes, and roots and tubers, with some of the other international centers (such as CIMMYT and IRRI) sharing the burden. To date, this approach has resulted in no viable packages based on new crop technology, in part because of the intractability of the crop adaptation problem, in part because such packages need to be tailored to the labor scarcity conditions of African agriculture.

On a national level, the situation of agricultural research in Africa is even more desperate. Kenya in this respect may be considered typical. As a recent AID assessment points out, 16 years of AID support for the Kitale Research Station, which produced the H611 hybrid maize that is one of the success stories of crop technology in Sub-Saharan Africa, produced only three

Ph.D.-level Kenyan plant breeders, none of whom is presently working in the country's maize research program. 52/

In some instances, foreign donors have actually reduced the ability of African countries to raise agricultural productivity by hiring away the few trained agriculturalists available within the country; such persons rarely return to the employment of the host government's ministry of agriculture once the donor project is completed.

The foundation on which to build a cadre of trained experts in agriculture is a sound system of primary and secondary education in the African countries. Yet at the present time aid for primary and secondary education ranks low on the list of priorities of aid donors.

The fact that the problem of the poor showing of agricultural research in Africa lies deeper than merely a lack of resources, human and financial, is borne out by the case of Nigeria, a country with relatively abundant investable resources on both counts. Here, within the past 10 years the administration of agricultural research has been entrusted to four successive organizations, each of which has enunciated policies and strategies in support of the government's goal of increasing food production. The number of agricultural research institutes in the country proliferated from 4 to 18, and subject areas of research were defined and redefined. These institutes have acquired impressive personnel rosters and equipment, carried on a wide range of research projects, and accumulated a substantial volume of research results, few of which have been analyzed and fewer communicated to persons in a position to use them. Some of the newer institutes have established networks of substations and experimental sites in spite of inadequate staff.

The situation in Nigeria has been described by Idachaba, who suggests a 4-year moratorium on further research work to allow retrieval, collation, analysis, and development of existing material. 53/

The design and implementation of agricultural projects in Africa on the basis of inadequate or inappropriate research findings is well illustrated by the fact that, according to one count, there have been over 150 projects in the francophone countries alone since the thirties using animal traction, yet the adoption of animal traction remains spotty. 54/ Researchers have identified a large number of constraints to use of animal traction, ranging from unfavorable cost and return relationships to cultural inhibitions of various kinds. There has been no agreement on how an animal traction technology package should be designed to overcome these constraints.

To reverse the demoralization of those in African countries who have been waiting for applicable research results, described by Idachaba, a strong new sense of direction needs to be conveyed. This involves, first and foremost, the identification of the problems to be worked on in order to put an end to the haphazard investigation of related and unrelated phenomena, and then agreement on a methodology. The bulk of the actual research task will obviously fall to the national agricultural research organizations. They have the indigenous crop varieties and implements that must serve as the foundation for developing new technology. They badly need to restore shaken confidence in their ability to produce useable results, and not least among those in influential political circles who must be of a frame of mind to defend the allocation of scarce resources to agricultural research.

The international research centers, however, and the developed countries in general, have an important role to play in giving this sense of direction.

On the basis of the centers` experience with the development of semidwarf wheats and rices, and their ability to apply sophisticated techniques and equipment for collation and analysis of large quantities of data, they should be in a position to design a methodology for foreshortening the research process for crops and implements. After an appropriate methodology has been developed, the African countries will be able to concentrate their resrouces on a research effort intended to design a package or packages capable of breaking the productivity bottleneck, instead of continuing to dissipate resources in an unscientific manner.

Several possibly fruitful areas for investigation have been suggested in this report. Very little research has been done on spontaneous innovation among subsistence farmers. Yet there is evidence to suggest that changes in cropping patterns are major vehicles for adapting to changing natural and social conditions. Furthermore, social arrangements may be vehicles for changes in production potential, as is the case when social patterns between settled agriculturalists and nomads provide for fertilization of fields and limited stubble feeding of livestock. The need to research the potential alternative cropping patterns has already been established in other developing regions (such as Asia). Less emphasis has been placed on studying the social environment as a source of indigenous innovation, more on its role as a constraint to externally induced technology diffusion.

Other areas where the payoff to research is likely to prove high (in terms of the design of government policies that are effective in increasing food production) are labor utilization and mechanization. In these areas, the focus needs to be narrowed considerably. The first priority in research on

labor utilization will obviously be to fill the present large gap in data in this area. It may be significant of the scant attention accorded this area that there exists, so far as is known, no national or international center for research on farm labor in Sub-Saharan Africa.

Estimates of Potential

A number of estimates have been made of the food production potential in Sub-Saharan Africa, based on resources presently available or likely to become available and assuming no technological change, and of the costs of producing enough to close the projected food gap by 1990.

Absolute Physical Limit to Production (MOIRA)

The authors of the MOIRA model 55/ have used a study of natural resources published in 1975 to estimate the absolute physical limit to agricultural production in the regions of the world. Under their assumptions, and using a grain equivalent factor of conversion, tropical Africa is found to be physically able to produce no less than 128 times the food it did in 1965.

Table 32 gives the results of the calculation of maximum production of grain equivalents (MPGE) for each of the 23 MOIRA soil classes present in Sub-Saharan Africa and its five sub-regions. In order to illustrate the magnitude of the gap between what the authors of the study consider to be the maximum physical potential of these soils and the present yields actually obtained on them, and for which we have records, we have presented data in table 33. The gap in yields is uniformly large. To fill the consequent production gap would require an investment in irrigation, fertilizer use, mechanization, extension services, and other inputs on a gigantic scale, although as the designers of the MOIRA model point out, maximum production might never be attained.

Table 32--Maximum production potential, Sub-Saharan Africa

MOIRA soil class	Region					
	Sahel	West Africa	Central Africa	East Africa	Southern Africa	Total Africa
	Million tons of grain equivalent/ year					
AB	81.3	189.7	0	0	0	271.0
A4	0	50.0	75.0	0	0	125.0
A5	0	0	237.0	0	0	237.0
A6	0	0	516.0	0	0	516.0
A7	0	0	0	8.0	0	8.0
A8	0	0	0	75.0	0	75.0
A9	0	0	0	113.0	0	113.0
A10	0	0	0	0	323.0	323.0
A11	0	0	11.0	0	0	11.0
B3	9.9	0	0	8.1	0	18.0
B4	748.0	140.2	0	46.8	0	935.0
B5	0	415.2	0	0	103.8	519.0
B6	0	0	0	244.0	0	244.0
B7	0	0	808.8	902.2	0	1,348.0
B8	0	0	492.5	0	492.5	985.0
B9	0	0	0	1,350.0	0	1,350.0
B10	0	0	970.2	0	648.8	1,617.0
B11	0	0	0	0	631.0	631.0
B12	0	0	0	0	598.0	598.0
B13	0	0	0	0	37.0	37.0
B14	0	0	0	0	89.0	89.0
B15	0	0	0	0	221.0	221.0
B16	0	0	0	0	114.0	114.0
Total	839.2	1,132.1	3,110.5	2,047.1	3,256.1	10,385.0

Source: Hans Linnemann, Jerrie De Hoogh, Michiel A. Keyzer and Henk D. J. Van Heemst, MOIRA: Model of International Relations in Agriculture, Amsterdam. Calculated by IED from data in appendix table A2.3 and Fig. 2.9. North Holland, 1979.

The Food Gap as a Projection of Present Trends

The International Food Policy Research Institute and FAO recently projected present production and consumption trends in Africa to arrive at an estimate of the food gap by 1990.56/ IFPRI and FAO also calculated the likely cost of filling this food gap. IFPRI's cost data, in 1975 dollars, cover 24

Table 33--Comparison of crop yields by soil class, Sub-Saharan Africa

MOIRA soil class	Relative area in Africa	Yield: MOIRA "MPGE/PAL"	Yield: Representative observation	Country and crop of representative yield
	Index	Thousand kilograms/hectare		
A3	2.28	16.9	0.93	Upland rice, FAO demonstration control plots, Sierra Leone
A4	1.00	17.6	.88	Maize, avg. Littoral Prov., Cameroon, 1977-78
			1.448	Rice, avg. Prov. Ouest, Cameroon, 1977-78
A5	1.31	25.5	6.6	Cassava, Equateur Prov., Zaire, avg. 1970-74
A6	4.44	16.4	.69	Maize, Eastern Kasai Prov., Zaire, avg. 1970-74
A7	.21	5.3	.77	Teff, FAO demonstration control plots, Ethiopia
A8	1.47	7.2		NA
A9	1.09	14.7	3.11	Maize, FAO demonstration control plots, Kenya
A10	2.21	20.7	.743	Maize, avg. Manica e Sofala District, Mozambique 1970
A11	.48	3.2	.452	Maize, avg. coastal Angola, 1970-71
B3	6.57	.4		NA
B4	12.03	11.0	.306	Millet, avg. 30 demonstration control plots, Niger, 1978
B5	3.74	19.7	10.9	Yam, test plots, Bouake, Ivory Coast, 8-yr. avg.
			1.56	Rice, FAO demonstration control plots, Ivory Coast
B6	6.21	5.6		NA
B7	11.62	16.4	1.055	Maize, avg. Prov. Nord-Ouest, Cameroon, 1977-78
			.41	Maize, central Angola, 1970-71
B8	6.72	20.7	.65	Maize, Shaba Prov., Zaire, avg. 1970-74
B9	8.89	21.5	.75	Mazie, Tanzania, 1976-77
B10	13.22	17.3	.374	Maize, eastern Angola, 1970-71
B11	5.07	17.6		NA
B12	4.27	19.8	.80	Sorghum, FAO demonstration control plots, Lesotho
B13	.35	14.8		NA
B14	3.25	3.9	.58	Sorghum, FAO demonstration control plots, Botswana
B15	1.77	17.7	2.0	Irrigated rice, Tananarive, Madagascar, 1965
B16	1.80	9.0	1.4	Rainfed rice, Tulear, Madagascar, 1965

NA = Not available

Sub-Saharan African countries, while FAO`s study includes all Sub-Saharan Africa. (Sudan is omitted because of differences in regional alignments.) Table 34 gives some idea of the magnitude of costs involved. Unlike the production figures arrived at in the MOIRA study, IFPRI`s and FAO`s production estimates are well within the range of feasibility.

Table 34-- Estimated investment requirements for closing the food gap, 24 selected countries, Sub-Saharan Africa, 1975-90

Type of investment	Amount of investment required: IFPRI	FAO 1/
	Thousands of 1975 U.S. dollars	
Irrigation infrastructure		
Training personnel for	3,132,100	4,784,000
irrigation	20,008	NI
Settlement of rainfed land	830,000	1,266,000
Road construction	859,000	NI
Electrification	2/ 4,311,000	NI
Fertilizer manufacture 3/	506,952	4/ NI
Improved seeds	18,960	5/ NI
Mechanization	1/ 702,724	5,153,000
Pesticide supply	96,655	NI
Storage improvement	1,065,666	NI
Research and extension	1/ 1,126,400	NI
Livestock development	NI	3,831,000
Total	12,699,465	15,034,000

NI = not included
1/ Less Sudan.
2/ IFPRI allocated $6 billion in U.S. currency to Africa for settlement of rainfed land, road construction, and electrification (p. 85).
3/ Calculated at $240 in U.S. currency per metric ton.
4/ Cost of fertilizer inputs estimated at $2,328,000,000 in U.S. currency annually by 1990.
5/ Cost of seed inputs estimated at $323,000,000 in U.S. currency annually by 1990.

Sources: Peter Oram, Juan Zapata, George Alibaruho, and Shyamal Roy, Investment and Input Requirements for Accelerating Food Production in Low-Income Countries by 1990, Washington, D.C., International Food Policy Research Institute, December 1979, various pages. Food and Agriculture Organization, Regional Food Plan for Africa, Rome, July 1978, Table E.-1.

FOOTNOTES

1/ J. Papadakis, Climates of the World and Their Agricultural Potentialities (Buenos Aires: Papadakis, 1966).

2/ FAO/UNESCO, Soil Map of the World, 1:5,000,000; Vol. VI, Africa (Paris: UNESCO, 1977).

3/ FAO, Report on the Agro-Ecological Zones Project; Vol. I, Methodology and Results for Africa, World Soil Resources Report No. 48 (Rome: 1978). Unfortunately, country and regional data are not yet available at the time of writing.

4/ Average of 42 farms in a sample in northern Nigeria. D. W. Norman, "Economic Rationality of Traditional Hausa Dryland Farmers in the North of Nigeria," in Robert D. Stevens (ed.). Tradition and Dynamics in Small-Farm Agriculture, (Ames: Iowa State University Press, 1977), p. 74.

5/ Note that use of labor or any other input could serve as the basis for such a classification.

6/ Hans Ruthenberg, Farming Systems in the Tropics, (Oxford: Oxford University Press, 2nd. ed., 1976).

7/ Ruthenberg, op. cit., p. 16.

8/ See below, "Risk Bearing."

9/ Explained below.

10/ D. Norman, I. Ouedraogo, and M. Newman, The Farmer in the Semi-Arid Tropics of West Africa; Vol. I, Interpre tive Review of the Literature (Hyderabad, India, ICRISAT, n.d.) pp. 104-106.

11/ Ibid., p. 108.

12/ Ancey, "Niveaux de décision et fonctions objectives en milieu rural africain," AMIRA, No. 3 (Paris: INSEE, 1975).

13/ E. Hopkins, "Wolof Farmers in Senegal: A Study of Responses to an Agricultural Extension Scheme," unpublished Ph.D. dissertation, University of Sussex, 1975.

14/ AID, Africa Bureau: Agriculture/Rural Development Function Review (Washington, D.C.: 19 July 1979).

15/ "Most of the potentially arable land that is not farmed is in the tropics of Africa and South America, about 1 billion hectares or three-fourths again as much land as is presently cultivated in the world." (National Academy of Sciences, World Food and Nutrition Study: The Potential Contributions of Research. (Washington, D.C.: 1977, p. 88).

16/ J. M. Kowal and A. H. Kassam, Agricultural Ecology of Savanna: A Study of West Africa, (Oxford: Oxford University Press, 1978), pp. 167-176.

17/ It should be noted in passing that data on crop yields in Africa rarely take into account the fallow period. Yet obviously in cases where land must be rested for five years after raising a crop, its annual yield should actually be expressed as a relation covering output for the total six years of land utilization, and not merely for the sixth of that period. A shortening of the fallow period therefore implies a higher yield per hectare, even with constant or declining soil fertility. These relationships are explored more fully below.

18/ SCET-International, "Outline of Water Resources Development in the West African Sahel."

19/ Most of the data cited here are from World Bank country reports and SCET-International, "Outline of Water Resources Development in the West African Sahel."

20/ Most of the dam construction projects in Sub-Saharan Africa have been justified on wider grounds than agricultural production (such as hydroelectric power generation). Under African conditions of highly variable river flows, the cost of flood protection works associated with large dams adds enormously to their over-all cost.

21/ FAO, "The Economics and Planning of Irrigation, Report to the Government of Tanzania," Rome, 1972.

22/ Norbert Beyrard, "Programme Intégré de Développement du Bassin du Sénégal" (Paris: 1974), Vol. V., p. 25.

23/ D.W. Norman, "Economic Rationality of Traditional Hausa Dryland Farmers in the North of Nigeria" in Robert D. Stevens (ed.), Tradition and Dynamics in Small-Farm Agriculture (Ames: Iowa State University Press, 1977), pp 84-85.

24/ On labor scarcity in African agriculture see J.C. de Wilde and World Bank country reports.

25/ V.W. Ruttan, "Usher and Schumpeter on Invention, Innovation, and Technical Change," The Quarterly Journal of Economics, LXXIII, 4 (November 1959), p. 606.

26/ See page 146 , below.

27/ See Appendix B, "A Note on Technical Terms."

28/ AID, "Kitale Maize: The Limits of Success," Dec. 1979; John Gerhart, "The Diffusion of Hybrid Maize in Western Kenya," CIMMYT, 1975.

29/ Institut National pour l'Etude Agronomique au Congo.

30/ Information from William I. Jones, IBRD.

31/ A H. Kassam, "Crops of the West African Semi-Arid Tropics," Hyderabad: ICRISAT, 1976, p. 21.

32/ Ralph W. Cummings, Jr., "Food Crops in the Low-Income Countries: The State of Present and Expected Agricultural Research and Technology," New York: Rockefeller Foundation, May 1976.

33/ Kassam, op. cit, p. 17.

34/ Kassam, op. cit., p. 9.

35/ "Though undoubtedly distinct types, the morphological differences are small, O. glaberrima having shorter, truncate ligules (6 mm. against 15 to 45 mm.), fertile lemma and palea, and simple undivided panicle branches as compared with O. sativa which bears short branchlets." (D. H. Grist, Rice (London: Longman, 5th edition, 1975) p.62.)

36/ M. Arraudeau, "Rice Breeding in Malagasy Republic," in I. W. Buddenhagen and G. J. Persley (eds.), Rice in Africa, (New York: Academic Press, 1978), p. 132. Rice research in northern Nigeria can also be traced back to 1927.

37/ IITA, "Research and Training Activities at IITA," Sept. 1979, pp. 36B and 36C.

38/ Information from Djibril Aw, IBRD.

39/ Dana G. Dalrymple, Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations, (Washington, D.C.: USDA, 6th ed., 1978), p. 57.

40/ See M. Verlet, J. Hauchecorne and M. Georges, "Wheat Production at Lake Chad," in Peter McLoughlin Associates, Agricultural Development Projects in Francophone Africa.

41/ IITA, op. cit., pp. 13-19.

42/ The Tanzanian experience with tractorization is summarized in World Bank Report No. 1616-TA (Dec. 1977).

43/ Christopher L. Delgado and John McIntire, "Economic Constraints on Farming with Plow Oxen in the Sahel," mimeographed, July 1980, pp. 3-7.

44/ Andrew C. Coulson, "Tanzania's Fertilizer Factory," Journal of Modern African Studies, Vol. 15, No. 1 (March 1977), pp. 119-125.

45/ "The estimation of fertilizer demand has not followed any scientific methodology; it is at best a guestimate of the experienced persons, tempered by the budgetary constraints of the Federal and State governments." (Nigeria, Federal Ministry of Agriculture, "The Green Revolution: A Food Production Plan for Nigeria," Vol. 2, (1980) p. 89.)

46/ In Kenya, higher maize yields were offset by transfer of land from maize into more profitable cash crops, producing no clear production trend. Maize acreage in Zambia is also reported to be trending downward. Cameroon was able to achieve an exceptionally high rate of growth of maize production of 7.79 percent annually between 1972 and 1978, according to one report reviewed.

47/ WARDA estimates that rice production in West Africa is rising at a 5 percent annual rate.

48/ FAO, Regional Food Plan for Africa.

49/ See, for example, Steven Franzel, "An Interim Evaluation of Two Agricultural Production Projects in Senegal: The Economics of Rainfed and Irrigated Agriculture," Mimeo (East Lansing: Michigan State University, June 1979) p. 24.

50/ Warren J. Enger, "The Government of Niger`s Agricultural Strategy and the Potential for Meeting Long-Term Goals" in AID, Niger Agricultural Sector Assessment, Jan. 1980.

51/ The following observation seems pertinent in this connection; "The inconsistency with which various forms of mechanization have been adopted by farmers may well imply that the particular types of mechanization which have been introduced do not, in fact, relax the most critical labor constraints on the system." (T. Kelley White, "An Overview of Dry Land Farming Research Activities," paper prepared for the Workshop on Sahelian Agriculture, Purdue University, Feb. 1 and 2, 1979, p. 9.)

52/ AID, "Kitale Maize," op. cit., p. 10.

53/ Nigeria, Federal Ministry of Agriculture, "The Green Revolution: A Food Production Plan for Nigeria (Final Report)," (May 1980), Vol. 2, End Paper 15, "Agricultural Research."

54/ Christopher L. Delgado and John McIntire, op. cit., p. 2.

55/ Described elsewhere in this report.

56/ International Food Policy Research Institute, Research Report 10, Dec. 1979; and FAO, Regional Food Plan for Africa, (July 1978).

CHAPTER IV. POLICIES AFFECTING FOOD SUPPLY

INTRODUCTION

Natural resources, technology, and the availability of inputs are major determinants of a country's ability to raise its food production from an existing level to one higher up. However, resources will not be committed and technological innovations will not be adopted by producers in the absence of appropriate incentives and a suitable economic environment. Agricultural, food, and other rural policies play a major role in creating and destroying incentives and in shaping the economic environment within which food producers operate.

The analysis of food production presented in the previous chapter has excluded any discussion of relative costs or prices to producers. Yet costs and prices change frequently in African countries. Moreover, governments of African countries (who themselves react to world market prices for their export crops) act as important influencers of costs and prices through their intervention in markets for food crops. Policies in such areas as producer prices and investment in rural infrastructure interact not only with elements of the system portrayed in figure 8, but also with one another. Trade policies of African governments are also an important influence in shaping the economic environment within which food production and marketing take place.

Policies affect costs and benefits which farmers obtain from producing food crops. Attempts to stimulate production through use of government policies are based on the assumptions that: (1) farmers will perceive true costs and benefits from policies as policymakers do, and will respond to

them; and (2) that policies, if implemented, will produce the effects intended.

Farmers in African countries can be expected (on the basis of much empirical evidence and other things being equal) to respond positively to perceived price incentives in making their decisions about production of food crops. Moreover, an important benefit from higher producer prices is higher income, since a large proportion of African farmers (and most particularly those in the poorer categories) enter the marketplace in the off season to purchase food to tide them over until harvest time.

However, a higher producer price may not elicit the expected response (for example increased production) because the price announcement or payment for the crop is not received in time. This is an example of how a constraint in the form of poor communications can, and often does, operate to make the assumption under (1), above, invalid. Then again, price controls and procurement restrictions enacted by a government encourage the development of an unofficial market. If the official producer price differs greatly from the free market price, and government controls are inefficient, an actual dual pricing and marketing structure develops. Official prices tied to official marketing channels coexist with informal prices linked to a free market, thereby weakening the impact of government pricing policies. This is an example of how a constraint in the form of price fluctuations resulting from irregular supply negates the assumption under (2), above. Similar constraints operate elsewhere to the same effect.

The discussion of policies affecting food supply here groups policies into four broad categories. First, a group of policies affect more or less

directly, prices producers receive and how much they sell. Second, a group of policies affects the inputs farmers use, including purchased inputs, land, and human capital. The third group affects commodities after they are sold by the farmer and before they are bought by the consumer. A fourth group of policies emanating from governments concerned with their financial position deal with such matters as trade and foreign exchange balances, and these affect food supply.

POLICIES AFFECTING FARMERS` INCENTIVES

Policies may affect all parts of the food system. The production and procurement of crops depends upon the farmers` perceived costs and benefits. Policies may affect these perceptions.

Benefits

The benefits to the farmer are seen in terms of total sales and prices received. There are many policies which have an impact on these variables. Many governments attempt to control outright the price received by the farmer and the amount sold to the marketing agency in order to control production and procurement of various commodities.

The types of price controls and procurement policies used vary from country to country, but the major distinction is between minimum price supports, a price policy without procurement restrictions, and a legal monopoly over a crop, a price policy with total procurement restrictions. The mimimum price support acts as a floor on the price allowing farmers to sell where they wish. In years of bumper crops and low free market prices, the farmers would be able to sell to the marketing agency at a price above the free market price. In years of tight supplies and higher prices, the farmer

would sell on the open market. The latter policy restricts the farmer to selling only to the marketing agency at a set price. A minimum price support policy is more easily implemented. In many countries where there ae procurement restrictions, black markets predominate.

In West Africa and Central Africa, there is no legal monopoly over most of the staples. In other regions of Africa the controls are theoretically more complete. All the 26 countries that grow rice have official producer price controls. In half of these cases, the marketing board has a legal monopoly over procurement. Maize is also highly regulated. Of the 25 countries that have official producer prices for maize, 12 have marketing agencies with legal monopolies (table 35). The effectiveness of these controls varies considerably from country to country.

The difficulty in procurement resulting from producer price controls and procurement restrictions may encourage the development of policies to ensure that procurement will take place. Thus there is a bias created toward large-scale and inefficient cultivation where the government has tighter control over output. Mali, for example has much better success in procuring rice from the large development schemes, where marketing requirements can be enforced.

This bias toward large-scale production encourages the use of imported inputs, which must be paid for in foreign exchange. One of the reasons advanced for increasing food self-sufficiency is the desire to become less dependent on imports. Importing inputs however, is usually to replace one form of dependency with another. Mechanized agriculture may be very costly and the costs will increase with rising petroleum prices. The supply of fertilizer may also be costly, and unreliable. Developing an agriculture

Table 35--Producer price controls and procurement restrictions by region, Subsaharan Africa

Region, number of countries and crops	Countries in region which grow crop	Countries with producer price controls	Legal monopsony on crop procurement
	- - - Number - - -		
Sahel, 8 countries:			
Rice	7	7	6
Wheat	1	-	1
Millet/sorghum	8	5	4
Maize	8	5	5
Roots and tubers	8	-	-
West Africa, 10 countries:			
Rice	10	9	1
Wheat	1 1/	-	-
Millet/sorghum	10	-	-
Maize	10	3	-
Roots and tubers	10	1	-
Central Africa, 5 countries:			
Rice	5	4	1
Wheat	2 1/	1	-
Millet/sorghum	4	-	-
Maize	5	5	1
Roots and tubers	5	5	1
East Africa, 8 countries:			
Rice	1	1	1
Wheat	4	4	2
Millet sorghum	8	3	2
Maize	4	5	3
Roots and tubers	5	-	-
Southern Africa, 9 countries:			
Rice	3	4	2
Wheat	4	3	1
Millet/sorghum	8	1	1
Maize	8	6	-
Roots and tubers	5	-	-

1/ Production negligible.
Source: IED research.

based on costly and unreliable imported inputs does not solve the problem of unreliable food imports.

Pricing and procurement policies which are inconsistent with other policies can be very costly. Pricing policy meant to encourage food production can be easily undermined by import policies. The subsidization of basic food grains can create a supply of grains at low cost at an unoffical price. The farmers would sell to the marketing board at the offical price because it is higher than the unofficial price and the marketing board is put in a position of buying grains that are already plentiful and thus subsidizing both producers and consumers.

Price controls which are coupled with panterritorial pricing, so that every producer is offered the same price for a crop, are also very costly. No price adjustments are made for variations in marketing costs from one area to another. Transportation costs are also not taken into account in the panterritorical pricing structure. The public agency must pay for the differences in transportation costs. Private operators tend to handle low-cost marketing leaving the higher cost transactionsto official marketing agencies.

Costs

The costs as well as benefits to a farmer also figure heavily in on-farm decision making. The major costs are the costs of the various inputs, including land, labor, and capital. Policies which affect the farmer`s costs are input subsidies, land tenure policies, taxes on output, credit, extension, research, and education.

Land tenure policies vary from area to area. May countries have attempted to institute state farms in one form or another, often at a high cost. Implementation is difficult. Large-scale production requiring mechanized production does not have a sufficient support system in most of Africa. Use of machinery requires proper maintenance, a ready supply of spare parts, and effective management. Management and mechanical skills are in very short supply in Africa. Spare parts, which must always be imported, are very costly and the supply is unreliable because of foreign exchange constraints.

An interesting use of land tenure policy to influence production decisions, in the case of smallholders, is found in Sudan. Under the Gezira and other large irrigation schemes, the state owns the land, but rents it to tenants. The average size of holding in these schemes is said to be about 15 hectares. The state intervenes in dryland agriculture as well. In all, large public corporations in Sudan control an estimated 100 percent of production of sugar, 98 percent of cotton, 93 percent of wheat, 68 percent of sorghum, and 46 percent of groundnut and sesame. 1/

Tanzania has attempted a "villagization" program which does not depend on mechanized agriculture. One of the main purposes of the program was to concentrate the widely dispersed population so that people would have easier access to government services. But again, the management constraints have made implementation difficult. Massive management training has taken place at great cost. The success has varied from area to area.

Input subsidization (particularly for fertilizer) exists in many countries in order to affect production decisions. But additional inputs will not be used to increase production unless there is a place to sell the additional

crop at an appropriate price, and money to buy the input in the first place. Without the appropriate pricing, marketing, and credit policies, input subsidies are ineffective. The use of subsidized fertilizer played a major role in the Green Revolution in India. During the sixties the government-regulated prices of ammonium sulphate, widely used in wheat production, rose 47 percent, while the procurement price of wheat rose 103 percent. 2/ But many of the other conditions were there to encourage its use. There were appropriate production price incentives a good infrastructure and on already commercialized agriculture.

Education, extension, and research may increase the efficiency of the farmer. Better information and new skills improve farm management capabilities. As with other inputs, these new skills will not be used unless other conditions are appropriate.

MARKETING POLICIES

The marketing of products, that is, the transportation, storage, processing, and packaging of commodities, has an important impact on the cost of the product. The people who perform these functions must have an incentive. If the marketing is done privately, it must be profitable. The alternative is for a public agency to handle these functions. In West Africa, the private entrepreneur thrives with official approval while in the Sahel official marketing agencies are legally responsible for performing these functions for most food grains.

Price policy has an important impact on the ability of these agencies to market the commodities. Inappropriate prices would encourage the circumvention of the system and encourage trade on the unoffical market.

High producer prices with their possible effect on marketed quantities could overload the system and make pick up and storage of the crops difficult and costly. Milling and packing have often contributed to high marketing costs because of the choice of technologies. The problem is common to milling authorities in both West Africa and East Africa, particularly in Tanzania. Large, capital-intensive milling equipment is cheaper than competing small-scale or hand techniques only if it is run at or near full capacity. Where official marketings are low, or where centrally used processing means shipping the milled produce long distances to consumers, costs are higher than using competing technologies. Absorbing these costs increases official marketing costs, and creates an economic incentive for informal processing as well as marketing.

Lack of proper storage facilities also affects other parts of the food system and can discourage procurement by the marketing agency. The uncertainty associated with the lack of consistent government action discourages production above what is needed for home consumption.

The lack of storage facilities in many countries make import and export policies a reaction to local weather conditions. In years of plenty, there are no means of holding the crop over, and prices are depressed and quantities are in great supply. In bad years, food must be imported.

Tanzania serves as an example where pricing structure as well as the lack of storage facilities proved very costly. In an effort to redistribute income to poorer areas, the authorities increased producer prices. This resulted in surplus of sorghum and millet without appropriate storage facilities to hold the crops over for another year. These crops had to be exported at a loss.

TRADE POLICIES

Fractional trading patterns have had a tremendous impact on present-day Africa. The structure of production and marketing has been oriented towards export crop production. Although trade policies vary from country to country, most countries remain export-oriented, receiving most of their foreign exchange from cash crops. Many countries are becoming increasingly interested in a policy of import substitution for food crops because of the financial burdens and uncertainty involved in relying on food imports.

Implementation of an import substitution policy for certain food crops is difficult for several reasons. The restriction of imports exerts an upward pressure on food prices and there is extreme political pressure in many countries to prevent this from happening. In addition, domestic production is not always efficient. The substitution of local rice for imported rice,for example,is very costly in many areas.

Import policies can influence production incentives. Cheap food, unless the farmer is insulated, has a depressing effect on prices received by farmers. Some countries may attempt to protect the farmer with high producer prices, but inefficiencies in the system often cannot prevent farmers from being adversely affected.

Foreign exchange rates also affect production. In most countries, the currency is overvalued, resulting in the subsidization of all imports. Agricultural production becomes increasingly dependent on imported inputs which may not be economically justified based on true costs.

CONSTRAINTS

There are many constraints in the attempt of a government to formulate and implement policies to increase food production. Financial contraints and managerial constraints are particularly severe.

Financial Limitations

Increasing agricultural productivity will require substantial investment in agriculture. Past investment in agriculture has generally been small (table 36). There are some exceptions. Chad, Congo, and Rwanda spent 20 percent or more of total current revenue on agriculture in 1973; Senegal, Burundi, Malawi, and Sudan invested more than 25 percent of total capital expenditure in agriculture.

New development plans generally call for slightly higher investment in agriculture. More than 25 percent of public investment is targeted toward agriculture in Ivory Coast, Kenya, Lesotho, Malawi, and Sierra Leone. 3/ However, most African governments already face serious resource constraints. For most of the poorest, plans will be pursued only with external assistance. In some cases, a very significant share of plan financing is external. Burundi, Mali and Swaziland expect more than 80 percent of their plan to be financed externally; Lesotho and Niger, 60 percent; Madagasgar, Sierra Leone, Mauritania, and Togo, 30 percent. 4/

African countries by and large face serious balance of payment problems which act as a constraint to greater imports of agricultural inputs (fertilizer) as well as to undertaking many large-scale projects which require imported materials or expertise (irrigation). For many countries, food and energy imports take a large share of their export earnings. Food imports are

Table 36--Investment in agriculture in selected countries, Sub-Saharan Africa

Region and Country	Agricultural expenditure as percentage of total of current expenditure		Agricultural capital investment as percentage of expenditure	
	1967	1973	1962	1973
	Percent			
Sahel:				
Chad	19.3	33.0	NA	NA
Gambia	9.0	11.4	9.8	21.4
Mali	16.6	18.9	NA	NA
Niger	9.3	NA	12.5	12.9
Senegal	5.5	5.6	26.1	27.7
Upper Volta	6.5	6.4	NA	NA
West Africa:				
Cameroon	13.9	11.5	NA	NA
Gabon	NA	NA	2.7	4.4
Ghana	7.3	6.9	10.5	6.3
Guinea	12.0	NA	27.6	NA
Liberia	7.3	6.3	1.3	NA
Nigeria	0.6	1.4	6.0	12.4
Sierra Leone	3.9	4.9	2.4	7.0
Togo	5.2	5.8	6.3	10.9
Central Africa:				
Central African Republic	8.3	6.5	NA	NA
Congo	15.8	20.2	NA	NA
Zaire	0.8	2.7	7.0	2.1
East Africa:				
Burundi	13.7	19.4	22.4	65.2
Ethiopia	23.3	19.8	3.8	12.6
Kenya	8.2	8.2	34.8	5.1
Rwanda	26.2	23.3	6.5	7.6
Somalia	6.5	3.2	NA	NA
Sudan	11.9	7.7	43.8	33.5
Tanzania	6.3	13.6	17.1	12.5
Uganda	7.9	7.1	25.2	20.6
Southern Africa:				
Botswana	4.8	11.5	26.3	1.6
Lesotho	8.4	9.6	15.6	12.9
Malawi	7.5	7.9	24.8	31.8
Swaziland	6.7	7.4	9.5	19.5
Zambia	5.6	14.6	9.5	23.0

NA = Not available.
Source: World Bank, World Development Report, 1979.

10 to 15 percent of many countries export earnings with cereal generally the major food import. For several countries--Gambia, Senegal, Sierra Leone, Togo, and Somalia--food imports take more than 25 percent of total export earnings. Energy imports take an even large share. Most countries spend at least 10 to 20 percent of their export earnings on energy. Chad, Mali, Cameroon, Ethiopia, Kenya, and Mozambique spend more than 25 percent.

Managerial Skills and Information Systems

An additional constraint is that people with managerial capabilities and information with which to make decisions are severely lacking in most African countries. In order to plan the economies to the extent that most governments attempt, they must be able to determine the tradeoffs among the various policy alternatives and be aware of the resources available to implement these policies. Managerial capabilities and information systems would have to be extraordinary under the circumstances. Different policies may interact and conflict or complement each other. The manager and planners must have information with which to predict the interaction. The expense of the inability to predict these outcomes can increase the burden on an already overloaded financial situation.

REGIONAL ANALYSIS

Policies affecting food supply in Sub-Saharan Africa are discussed in accordance with the regions defined in this study.

The Sahel

The region known as the Sahel extends along and beyond the southern edge of the Sahara desert. It comprises not only the Sahel ecological zone but also

portions of the Sahara, Sudan, and Guinean zones. The region includes eight countries--an island state, Cape Verde, three coastal states, the Gambia, Mauritania, and Senegal, and four land-locked states, Mali, Niger, Upper Volta and Chad. 5/ Although they differ in important respects, they share common characteristics based on their geographic location and resources.

The Sahelian countries are classified among the world's poorest countries. Only Niger and Senegal have a per capita GNP above $300. 6/ They are predominantly agricultural, highly dependent upon the amount and timeliness of rainfall, and remain vulnerable to frequent and at times severe drought conditions. Deforestation has intensified soil erosion and increased the desertification process.

Many of these countries during the sixties were basically self-sufficient in certain cereals and occasionally were able to export small amounts of grain to neighboring countries. During this past decade following the severe drought, the Sahel became increasingly dependent upon imported foodgrains. Many countries continue to suffer substantial shortfalls in production. Already low nutrition levels have been adversely affected and all the Sahelian countries continue to show caloric intake lower than the minimum daily recommendations.

Catalyzed by the drought and by the perception that mutual concerns and problems could be more effectively addressed on a regional level, the Sahelian nations formed the Permanent Inter-State Committee for the Fight Against the Drought in the Sahel (CILSS). 7/ The CILSS was originally created to mobilize emergency food and other assistance to the affected countries and help coordinate relief efforts in connection with the drought. Since that time,

the CILSS has taken on broader functions and has primary responsibility for coordinating longer term development assistance and planning regional level programs. The two basic goals of the CILSS are the achievement of food self-sufficiency and of eventual self-sustaining growth and development. Sector priorities and strategies were decided on by the CILSS member states, and a list of projects was designed within the framework of national development objectives. Interactions among member countries are thus institutionalized. CILSS countries meet on a regular basis to discuss the direction of regional policies as well as to coordinate programs with donor countries.

Food Production Record

In the past 15 years, food production in the Sahel has shown great variability due to inadequate and untimely rainfall. The drought which occurred in the late sixties and early seventies disturbed an already fragile environment. Fertility has declined because soils are being used more intensively and not allowed to lie fallow long enough to replenish themselves. Some improved varieties have been introduced, yet agriculture remains dominated by traditional techniques and systems.

Food production has failed to keep pace with population growth compelling the governments to import a varying portion of their food needs. Although overall quantities of food aid are much lower now than during the severe drought years 1972-1975, the need for such aid will likely continue to vary. While a protracted region-wide drought might not reoccur in the near future, localized droughts will probably continue in the Sahelian countries.

Many countries have suffered in recent years due to localized drought which has affected both food crops and income-earning cash crops. Both the Gambia and Senegal experienced serious shortfalls in the 1979-80 harvest. Provisional estimates suggest that the production of millet and sorghum in Senegal fell by almost one half from the previous year. Production figures for Chad are hard to verify, although it is clear that the country faces difficult problems concerning food supply and distribution. Mauritania is also experiencing a bad and deteriorating food situation. It is likely that Mali has sufficient in-country supplies to meet existing localized deficits, although at high prices. Outflows of grain to neighboring countries in response to price differentials could exacerbate this situation. Niger is the only country of the region which claims to be self-sufficient in grain in 1979-80.

Food and Agricultural Policies

The rural sector has traditionally received little attention from policymakers and has been generally taxed disproportionately to the amount of public expenditure allocated to it. Over the past few years, most of the Sahelian countries have sought to redefine and redirect aspects of their economic development. Through the CILSS as well as through national policy statements, agricultural and rural development are emphasized and encouraged. Allocations of public investment have increased significantly from prior plans.

Of uppermost concern to these countries is the ability to better withstand drought and increase food production. The achievement of food self-sufficiency has become a critical component of the countries' agricultural development strategies. Regional food self-sufficiency, however,

receives little attention in individual country development plans. Instead, primary emphasis is given to national food self-sufficiency. All the plans emphasize agricultural-based strategies of development in general and cereals production in particular. For most countries this means ambitious targets for millet, and sorghum, and increasingly, rice production. The latter has become particularly significant for Mali where there are plans for investment in irrigated agriculture, and for the Gambia and Senegal where the achievement of food self-sufficiency means the elimination of large rice imports.

In Mali, irrigated rice production is emphasized due to greater water control and less reliance on adverse weather conditions. The Development Plan foresees progressive substitution not only of domestically produced rice for imported rice, but also for millet and sorghum. The Senegalese Development Plan and the Food Investment Strategy call for measures which would encourage domestic production and import substitution so that 100 percent of maize, millet and sorghum, and 50 percent or rice imports could be eliminated. At present only one-fourth of total rice consumption is satisfied by local production. While a shift in consumption patterns in favor of millet and maize is envisioned, substantial increases in rice production are called for during the Plan period.

In Niger, although the Development Plan optimistically projects large increases in rice production, the major emphasis is on coarse grain production. Food self-sufficiency is defined as the ability of local cereals production to meet the food requirements of the population in both average and drought years without resorting in a systematic and increasing manner to imports of major food commodities.

Although millet, sorghum and to a lesser extent maize will remain the staple food crops throughout the region, it is likely that differences in urban and rural diets will be accentuated. Rice and wheat are becoming increasingly important food items in urban areas, a trend which is likely to accelerate and have important implications for the countries` self-sufficiency objectives. There is in fact little or no potential for wheat production.

It is clear that the manner in which food self-sufficiency is defined and the manner in which it is to be achieved differ from country to country. Stated policy pronouncements do not necessarily translate into actual policies, particularly when the implementation of these policies entails complex and often conflicting actions. There are often important tradeoffs between the achievement of this goal and alternative agricultural policies which might emphasize foreign exchange-earning cash crops. Food self-sufficiency, although a politically attractive objective, may in fact be uneconomic and unfeasible on a country-by-country basis. These tradeoffs and the complexity and ramifications of policy choices often result in agricultural policies that act more as disincentives than as incentives to the achievement of food self-sufficiency.

Land Tenure--Land tenure appears to be less of a constraint to agricultural development in the Sahel than in other parts of Africa. Though forms of traditional tenure prevail throughout the area, the low population density has put little pressure on the traditional system to change. Shifting cultivation is practiced in many areas and often land suited for farming is available.

However, there have been pressures brought to bear on traditional cultivation systems by pastoralists. During the last few years, increasing desertification of pasture lands has forced herders into some areas where they normally would not venture. Rights have been disputed and some legal problems resulted. Often the disputes are settled by customary means, rather than through the national governments.

In general it seems that little has been done by the governments to effect change in the traditional systems (table 37). The notable projects on the region which have affected large areas have been the Office du Niger in Mali, created in 1934, and the AVV (Autorité des Aménagements des Vallées des Volta). The former attempted to settle families in an area where irrigation infrastructure was installed for cotton and rice production, while the latter concerned the settlement of families in regions freed from certain parasitic diseases.

Table 37--Typology of land tenure patterns, Sahel 1/

Country	Individual title	State farm	Controlled schemes	Private, foreign-owned plantation
Cape Verde	-	X	-	-
Chad	-	-	-	-
The Gambia	-	-	-	-
Mali	-	-	X	-
Mauritania	-	-	-	-
Niger	-	-	-	-
Senegal	X	-	X	-
Upper Volta	-	-	X	-

1/ Communal land tenure predominates.
X = land tenure arrangement exists
- = land tenure arrangement does not exist or no information is available.

Producer Prices--Official producer prices for most agricultural commodities are set by government decree at the recommendation of a committee (such as the technical commission for cereals marketing in Upper Volta or the Comité des Grands Produits Agricoles in Senegal) and through the intermediary of the official state marketing agency. In most of the Sahelian countries, these state-run marketing boards are legally responsible for collecting and distributing cereals and for enforcing the official producer price (table 38). For a number of reasons however, including inadequate financial and managerial resources, these agencies have generally been unable to carry out their tasks. Consequently, they have handled only a fraction of marketed output.

In Chad, Mali, Niger, and Upper Volta 8/ there are controlled prices and official marketing channels for millet and sorghum. These countries have comparable marketing structures and except for Mali, comparable prices. (Official producer prices in the latter have been consistently lower than those in neighboring countries, thus encouraging the illegal outflow of cereals.) But despite the legal monopoly control of the marketing boards and the setting of official prices, most of the millet and sorghum transactions take place on the unofficial 9/ market at market-determined prices. Private traders are usually able to offer a higher price to the farmer; and they also have greater flexibility in timing of entry into the market and more direct contact with the producers.

In certain instances, however, the farmer is required to sell some of his crop to the marketing board at the official price. This is the case in Mali for farmers who are not part of a regional Opération. These farmers must sell

Table 38-- Producer price controls for food crops, Sahel

Country and major food crops	Has official producer price	Has official monopsony
Cape Verde		
Millet and sorghum	-	-
Maize	X	X
Chad		
Rice	X	X
Millet and sorghum	X	X
Maize	X	X
Roots and tubers	-	-
The Gambia		
Rice	X	X
Millet and sorghum	-	-
Maize	-	-
Mali		
Rice	X	X
Millet and sorghum	X	X
Maize	X	X
Roots and tubers	-	-
Mauritania		
Rice	X	X
Millet and sorghum	-	-
Maize	-	-
Niger		
Rice	X	X
Millet and sorghum	X	X
Maize	X	X
Roots and tubers	-	-
Senegal		
Rice	X	X
Millet and sorghum	X	-
Maize	-	-
Roots and tubers	-	-
Upper Volta		
Rice	X	X
Millet and sorghum	X	X
Maize	X	X
Roots and tubers	-	-

X = Policy or institution exists.
- = No policy or institution exists or no information is available.

their grain through the cooperative system to the Office des Produits Agricoles du Mali (OPAM) according to a quota set by a regional cereals committee. This rigid system is generally incompatible with the frequent variations in output and leads to the situation where villages or villagers must buy or sell their grain on the open market to either meet their quotas or dispose of the surplus. Farmers in remote areas generally have less opportunity to circumvent the official price and market since private traders find it more cost-effective to serve more easily accessible areas.

There is no official producer price for millet and sorghum in the Gambia or in Mauritania although in the latter there is some intervention by the Office Mauritanien des Céréales (OMC).

All the countries have an official producer price for paddy. In Mali, the state marketing agency OPAM handles a fairly high proportion of marketed output because rice production is more centralized than that of millet and sorghum and OPAM buys directly from the mills. In the Gambia and Senegal, official price policy has limited influence on the production and marketing of rice. The bulk of domestically produced rice is consumed on the farm while most of the remaining production is hand-pounded and traded at the local level.

The Sahelian Governments face a continuing dilemma concerning relative prices of food crops and cash crops, and the extent to which policies should favor one over the other. This is a particularly difficult issue for those countries who depend on the export of a cash crop for the bulk of foreign exchange earnings. Most farmers produce cereals primarily for domestic consumption and market only a small proportion of total output.

Despite recent increases in the official producer price for cereals to encourage production, it appears that for the Gambia and Senegal in particular, the production of groundnuts remains more profitable. However, good weather, transporation and storage incentives along with a sharp increase in the price for cereals can elicit a response from the producers, as was the case in Senegal in 1978/79. The official marketing agency ONCAD was able to collect over 100,000 tons of millet and sorghum in contrast to the usual 10,000 tons. Ironically, however, ONCAD was unable to sell most of the crop on the domestic market.

In Mali there has been a decline in acreage devoted to groundnuts and in groundnut production, which observers attribute to the decreasing attractiveness of groundnuts in relation to food crops. Farmers appear to have been responsive to the high free market prices for cereals by switching from groundnuts to cereals. The Government recently announced a significant price increase for groundnuts (from MF 60/kg to MF 80/kg) in order to increase production and marketed quantities. Producer prices for cereals were also increased, but these remain considerably lower than those in neighboring countries. However, the poor harvest in 1979 in certain regions of Mali encouraged large grain inflows from Upper Volta whose private traders are attracted to the high consumer price for millet and sorghum on the Bamako market. Although producer prices for millet and sorghum in Niger remained at the same level for the third consecutive year, they do not appear to be a constraint on the recent buying campaign when OPVN was able to buy some 78,000 tons of millet and sorghum.

Input Subsidies--Thoughout the Sahel, the use of fertilizers and other inputs has been limited and the access of cereal producers to such inputs has been even more severely constrained. The regional development organizations (and thus credit and extension services) were primarily oriented toward cash crops. Overall, the producer price for cereals has not been sufficient to warrant the use of modern inputs by the farmer.

All the Sahelian countries have subsidy policies which are implemented by state-run agencies. In Niger, the Government is pursuing a policy of heavy subsidization of agricultural inputs reflecting its desire to transfer income from the money-earning uranium sector to the rural sector. In 1978/1979, the average subsidy rate was 77 percent for animal traction equipment, 49 percent for transport equipment, 54 percent for fertilizer and 59 percent for pesticides. The Five Year Plan is projecting a very rapid and substantial increase in fertilizer and pesticide use, although there has been no explicit statement on long term policies concerning subsidies. Increased demand for and higher prices of inputs might well act as constraints on the continuation of high subsidization of these inputs.

These constraints have been more readily apparent in Mali and Senegal where the organizations responsible for subsidies and input procurement and distribution have incurred heavy financial losses. In Senegal, fertilizer is the principal subsidized input although fertilizer use is said to explain only 10 percent of total production. Unlike Niger, where differing types of fertilizer are subsidized at varying rates, Senegal has a nationwide uniform price. This has resulted in favoring farmers in the south who use more concentrated and higher cost fertilizer.

Prior to 1973/74, the provision of inputs was highly subsidized by the Malian Government. The farmers in the Opérations which focused on cash crops were the primary beneficiaries of subsidization. Following the financial difficulties of the Société de Crédit Agricole et d'Equipement Rural (SCAER), subsidies on capital equipment such as plows and carts were removed and those on fertilizers and pesticides were lowered significantly. Subsidies on mechanical services (used in rice production) remain relatively high. In many of the Sahelian countries, the operational inefficiencies of the responsible agencies have had a negative impact upon input procurement and distribution, and thus ultimately upon production. Reorganization of institutions and policies is currently underway in Mali and Upper Volta.

Little information is available on the level and distribution of input subsidies in the other Sahelian countries. Fertilizer has been fairly heavily subsidized in Chad, the Gambia, and Upper Volta, although its use has been destined primarily for cash crops--cotton in Upper Volta and Chad, and groundnuts in the Gambia.

Credit--The availability of agricultural credit is limited by inefficient management of credit programs and by the lack of secure sources of revenue or financial support for these programs.

In most countries, credit is extended primarily to producers of cash crops, and is available only to those farmers who participate in the regional development organizations or cooperatives. To the extent that these entities involve an increasing number of farmers there should be a positive impact on credit availability. In Niger for example, there has been significant growth in the cooperative movement and the credit association has given priority to meeting the needs of small farmers.

There has been less of a funding problem for the credit association in Niger due to rapidly increasing deposits by the Government and by semipublic organizations. In contrast, SCAER in Mali has had severe financial problems brought about by lack of repayment, spoilage of stored fertilizers and insecticides, and difficulties in obtaining earmarked revenues. As of 1976 there was no credit available for seed purchases. In light of these problems the Government is undertaking a reorganization which would transform the association into a credit institution similar to that in Niger. The provision of inputs and subsidies, heretofore the responsibility of SCAER, will be handled directly through the regional Opérations. The credit system in Upper Volta is undergoing a similar reorganization.

In Senegal as in other countries, credit is granted in kind through the cooperatives. In theory, credit requirements are fairly strict and Government policy has been to refuse credit to any cooperative which has not paid at least 65 percent of all repayments due.

In Mauritania, the Gambia, and Chad there is no formal or well established institutional credit system. In the Chad, private traders are the major source of noninstitutional credit to rural areas.

Agricultural Extension--Agricultural extension is handled within the cooperative structure or under the aegis of regional development organizations and projects. Until relatively recently these organizations focused primarily on cash crops, and thus the services offered through them were also directed towards cash crop production. In Mali for example, over three-fourths of the extension personnel were employed by the cotton and groundnut Opérations in 1973-74.

The regional development organizations and projects have taken on a broader range of responsibilities. Many have a more specific mandate to improve the access of cereals producers to supporting services such as agricultural extension. However, there continues to be a shortage of trained personnel.

In Niger, agricultural extension activities are coordinated by the Union Nigérienne de Crédit et de Coopération (UNCC). Agricultural extension personnel are assigned to each regional productivity project. Farmers who are outside a project zone have access to the services offered by the technical agents of the Ministry of Rural Development within the Department of Agriculture.

Most of the agricultural extension activities in these countries are budgeted directly through the regional organizations.

Crop Procurement--The marketing structure for cereals is characterized by a dual system which includes official state-run agencies and private traders. In Chad, 10/ Mali, Niger, and Upper Volta, the official grain marketing agencies have legal responsibility for, and theoretical monopoly over, collection and distribution of coarse grains. In the Gambia and Mauritania, there is no official market structure for coarse grains, although in the latter, the Office Mauritanien des Céréales (OMC) has certain responsibilities for cereals price stabilization. All the countries have some sort of official market structure for rice (table 39). For 1975 to 1979, the official agency in Senegal had legal responsibility for the marketing of coarse grains and rice. Now, however, collection and distribution responsibilities will revert back to the private traders.

Table 39--Major marketing institutions for food crops, Sahel.

Country	Marketing institutions	Acronym	Food crops covered 1/
Chad	Fonds du Développement et d 'Action Rurale/ Département Céréalier	FDAR/DC	All cereals
	Office National des Céréales	ONC	All cereals
The Gambia	Gambia Produce Marketing Board	GPMB	Rice
Mali	Office des Produits Agricoles du Mali	OPAM	All cereals
Mauritania	Office Mauritanien des Céréales	OMC	All cereals
	Commissariat à l'Aide Alimentaire	CAA	All cereals
	Société Nationale d'Importation et d'Exportation	SONIMEX	All cereals
Niger	Office des Produits Vivriers du Niger	OPVN	All cereals
Senegal	Office National de Coopération et d'Assistance pour le Développement	ONCAD	All cereals
Upper Volta	Office National des Céréales	OFNACER	All cereals

NA = Not available

1/ The procurement responsibilities of marketing institutions vary among countries and actual procurement of commodities may vary from official procurement responsibilities.

Most agencies which handle the marketing and distribution of domestic production also have responsibility for the acquisition and distribution of imported grains. In Mauritania most of the imported food is in the form of

food aid and is now handled by the recently formed _Commissariat à l'Aide Alimentaire_ (CAA).

The official agencies were created by their respective governments in response to the perceived inequities of private trade, and were an attempt to "rationalize" trade flows within the country. They are typically responsible for the collection, storage, transportation, and distribution of cereals, as well as for security stocks and price stabilization. None of the official marketing agencies have in fact been able to fulfill their tasks. The agencies have responsibility without power. Although their efficacy varies by country, all have suffered from the lack of financial and managerial resources required to have an impact on supply and demand. Marketing margins are highly controlled and are too narrow to allow the agencies to cover their costs.

In response to the official agencies' inefficiencies in the cereals market, and despite attempts at an enforcement of their monopoly, private trade has flourished. Between 70 and 90 percent of the cereal trade is assumed to move through private channels. Overall, official marketing policies have been directed at denying the existence of the private sector although in some of the countries governments have tried to legitimize certain activities of private traders. In Mali for example, due to localized food deficits, the Government has relaxed restrictions on private traders importing and transporting grain. As a result there has been an influx of grain from Niger and Upper Volta, as well as from surplus regions within the country.

The governments are aware of the deficiencies of the present system and are attempting to redefine the roles of official agencies. In Niger, the Five Year Plan acknowledged the role of private traders and the need to resolve the

conflict between producer and consumer prices but failed to set any concrete policy directives. The Government of Mali has also recently undertaken a review of OPAM's role and responsibilities. As for ONCAD, which had perhaps the worst record for official marketings, the Senegalese Government made the decision for the 1979/80 agricultural campaign to relieve the agency of its monopoly role. The responsibilities for domestic marketing of millet, sorghum, and rice have reverted back to private traders, who will buy at support prices and operate on commission.

In sum, the official marketing system has not encouraged production or marketing of food crops. The redirection of the role of official agencies and the acknowledgement of the useful role played by private traders is an important step in changing this situation. However, it will be necessary to make substantial improvements in supporting services such as transportation, storage facilities, and information networks to ensure an effective and efficient marketing system.

Transportation--The inefficiency and inadequacy of transportation infrastructure, particularly in rural and outlying areas, are important constraints on the marketing process. Many roads are impassable during the rainy season and certain areas must rely on seasonal river transport. The landlocked Sahelian countries have additional constraints in that they lack access to the sea and are therefore burdened with high transportation costs in gaining access to world markets.

The limited transport capacity of the official marketing agencies adds to their already serious problems of collection and distribution. In addition, the panterritorial pricing system in effect in most of the Sahelian countries

disregards the often high transport costs. Since the official agencies operate within narrow marketing margins, these high costs mean that there is considerable financial loss. Outlying areas that are difficult to reach are served primarily by the official agencies since private transporters usually hesitate or even refuse to go to certain localities. Certain agencies contract out to private transporters although their services are often too costly for the already deficit-ridden official agencies.

The financial problem is indeed acute and can create bottlenecks for the delivery of needed foodstuffs. In Senegal, the Government recently requested financial assistance in order to transport domestically produced grain from surplus to deficit areas. In Chad, the problem is both financial and political. The continuing civil unrest has all but stopped internal transportation between north and south, and there is currently no effective official or private marketing system. In Mali, the lack of adequate and efficient transport infrastructure is particularly serious. Distribution problems become more important than aggregate production levels since, even if the latter are adequate, there is considerable trouble in moving grain from surplus to deficit regions.

Storage--Onfarm storage of cereals is extensive throughout the Sahelian region although no firm figures exist for actual storage capacity. The Sahelian Governments do not encourage farmers to increase storage capacity since farmers who grow primarily for their own subsistence are not considered as active participants in the marketing/distribution system.

In contrast, there has been a great effort on the part of Sahelian governments to increase central storage capacity. In Mali, Niger, and Senegal,

the storage capacity controlled by the official marketing agencies reaches or exceeds some 100,000 tons. Most of this capacity is located in large urban areas and is not greatly decentralized.

Despite the perceived need for increased storage capacity, the grain available for public storage purposes is limited with the result that most of the existing capacity is underutilized. This situation arises from the fact that the official marketing agencies have not had the financial or managerial resources to collect, transport, store, or distribute grain in any great quantity.

Trade--All the Sahelian countries have traditionally been export oriented, depending on one or a few commodities for an overwhelming portion of their foreign exchange earnings. Chad, the Gambia, Mali, Upper Volta, and to a somewhat lesser extent Senegal depend primarily on the production and export of agricultural commodities (groundnuts and cotton), while Mauritania and more recently Niger depend on the export of iron ore and uranium respectively.

While the recent government emphases on food self-sufficiency have not, and probably will not, radically change the export orientation of the economies, it has led to a greater focus on import substitution. Many countries are seeking to expand rice production in order to satisfy growing urban demand and save foreign exchange through a reduction in imports.

In support of their various objectives, the Sahelian governments have instituted an extensive array of import and export controls. On the import side, the respective governments maintain controls on basic foodstuffs such as wheat flour, sugar, rice, and vegetable oils. The quantity imported is regulated by state-run agencies which often also oversee the distribution of

the commodity (table 40). In most cases, price increases are absorbed by the governments and the items are passed on to the consumer with a substantial subsidy. Most recently in Senegal, price increases for certain goods were passed on to the consumer.

Most of the Sahelian countries continue to rely on substantial commercial food imports. Wheat and rice are important import items, the latter particularly in the Gambia and Senegal. In Senegal, for example, rice imports exceed 200,000 tons annually representing over half of all imported grain and some three-fourths of domestic rice consumption. Large quantities of rice were originally "dumped" in Senegal by the French from Indochina and by the large Office du Niger project in Mali. The preferred imported rice is a relatively low cost Thai rice (high percent broken).

Food aid is generally handled through a separate commission and distributed to specific target groups either for a nutrition program or to cover localized deficits. There is usually free distribution of a portion of the food aid with the rest being sold on the market at the official prices. In Mauritania, government policy had been to distribute all donor-received grain to the needy. However, this policy was recently changed due to its disincentive effect on domestic production. Most imported grain is sold on the market at the official price.

Particularly during the drought years after 1972, the Sahelian governments relied heavily on food aid. Although overall levels of food aid are substantially lower than in the mid-seventies most of the countries have recourse to this aid in times of substantial shortfall and recurrent drought. P.L. 480 Title II (grants) has played an important role in the total food aid

Table 40--Import record and policies, Sahel

Country	Average annual food self-sufficiency ratio, 1976-78 1/	Average annual cereals imports, 1976-78 2/	Average annual P.L. 480 food aid, 1976-78 3/	Import restrictions 4/
	Ratio	--1000 Metric Tons--		Policy
Cape Verde	NA	NA	11.9	NA
Chad	100	14.2	13.7	NA
Gambia	52	40.9	3.2	Quotas/Licenses: rice, wheat
Mali	99	30.8	7.9	Quotas/licenses: rice, wheat
Mauritania	5/ 32	122.0	11.7	NA
Niger	97	23.4	12.9	NA
Senegal	59	154.4	28.0	Quotas/licenses: rice, wheat
Upper Volta	97	39.0	20.2	NA

NA = Not available.

1/ The food self-sufficiency ratio is calculated as:

$$SSR = \frac{\text{per capita production of cereals}}{\text{per capita consumption of cereals}} \times 100.$$

The SSR for each country as calculated using data from the U.S. Department of Agriculture, Global Food Assessment, 1979, Table II-9 and the Food and Agriculture Organization, Production Yearbook, 1978.

2/ Food and Agriculture Organization, Production Year book, 1978: International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

3/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources, Food for Development in Subsaharan Africa, March 1980. Statistics in this report were orginally from Food for Peace Annual Reports, Africa CP 1980 and other Food for Peace documents.

4/ Economics, Statistics and Cooperatives Service.

5/ 1976-77 average.

received by the Sahelian countries, and Title III (food for development) is under consideration for several countries. From available data for FY 1980, the bulk of Title II was in the form of grain sorghum.

Export controls are in effect in all the countries. In most years the export of cereals is illegal. However, important contraband flows of cereals between neighboring countries exist in response to price differentials. This is the case between Senegal and the Gambia and between Mali and most of her neighbors. Official producer prices in Mali are much lower than those in neighboring countries and traders take advantage of high parallel market prices. Most recently there were grain flows from Upper Volta to Mali in response to a very high consumer price on the Bamako market. In the sixties Mali was a net exporter of cereals and could regain this position, although numerous policy changes are needed.

Table 41-- Selected indicators, Sahel.

Country	Population, 1977	--Urbanization-- Percentage of total population, 1977	Average annual growth rate 1970-75	Per Capita GNP, 1977,	Agriculture as percentage of GDP, 1977	Average annual growth rate, GDP, 1970-76	Average annual growth rate, per capita food production, 1965-79	--Transportation-- Total roads	Paved roads	Rail roads
Cape Verde	.3	NA	NA	180	NA	NA	NA	NA	NA	0
Chad	4.2	16	6.8	130	52	0.8	NA	27,505	242	0
Gambia	.5	NA	NA	220	50	NA	NA	2,390	317	0
Mali	6.0	19	5.3	110	1/ 38	3.5	-0.13	15,699	1,669	642
Mauritania	1.3	26	14.4	270	26	2/ 2.3	NA	6,090	558	650
Niger	4.7	11	6.8	160	1/ 47	1.8	-1.29	7,656	1,892	0
Senegal	4.6	24	8.0	430	1/ 28	2.8	-1.62	13,869	2,960	1,033
Upper Volta	6.3	9	3.6	130	37	3.3	-2.77	14,207	859	1,173

NA = Not available.
1/ 1976 data.
2/ 1970-77 data.
Source: See Appendix tables 1, 2, 3.

West Africa

The 10 countries of West Africa share many features based on their geographic location and colonial heritage. They also exhibit significant diversity with respect to population size, land area, natural resources, level of development, and current political structures. Nigeria clearly predominates by virtue of her land area and a total population which is more than double that of the other West African nations combined. Nigeria's prominent petroleum sector also sets the country apart from others in the region. This sector dominates export trade, providing 90 percent of total foreign exchange earnings.

The Ivory Coast has an important place within the region, employing a large number of migrant workers from neighboring countries and providing those countries with a variety of semiprocessed and light-manufactured goods. Despite a recent slowdown in economic activity, the country has experienced fairly steady economic growth and is significantly more prosperous than most of her neighbors. In contrast, Ghana is currently faced with severe economic difficulties.

Politically, these countries exhibit important differences. There are varying political structures including a socialist military regime in Benin and one party systems in the Ivory Coast and Sierra Leone. Many of the countries have had relatively stable political environments. This has not been the case in Ghana, where there has been a succession of military and civilian shifts since 1966, nor in Liberia where a military coup took place in early 1980.

Despite relatively favorable resource endowments including a variety of minerals, the countries in West Africa are among the world's poorest. Even with petroleum wealth, per capita GNP of $477 classfies Nigeria as a lower middle-income country. The Ivory Coast has the highest per capita GNP with $690, while Benin, Guinea, Guinea-Bissau, Sierra Leone, and Togo are classified among the lowest income countries with per capita GNP below $300. The average rate of growth of this indicator was minimal or negative for most of the countries during the 1970-75 period.

All the countries have access to the sea and traditionally have had export-oriented economies based on one or a few selected commodities. Despite substantial mineral resources, the region remains predominantly agricultural. This sector provides employment for the majority of the region's population and in six of the countries accounts for between 45 and 76 percent of total foreign exchange earnings. West Africa has traditionally been more urbanized than other regions of the continent and urbanization has been increasing rapidly in all the countries.

Although there was no dramatic catalyst for increased policy coordination as in the Sahel at the time of the drought, there is a long history of formal and informal interraction among the countries in West Africa. Numerous institutions serve a variety of economic, social, and political interests. Several of these organizations such as the Economic Community of West African States--ECOWAS--include all the countries in the region,[11/] while others such as the Mano River Union have a more limited membership and mandate.

Interregional transactions have been facilitated by these institutions although official trade remains limited. Unofficial trade cannot be precisely

documented, but is clear that it is both substantial and on the increase. Seasonal and permanent migration both within and between countries of the region and between the Sahel and West Africa is significant. In the Ivory Coast alone there are some 2.5 million migrant workers doing the bulk of agricultural work.

Food Production Record

In the last 15 years, the food production record in West Africa has generally been mediocre. Although certain countries are close to self-sufficiency in some foods, production has failed to keep pace with food demand of the growing population in many of the West African countries. Demand is particularly strong in urban areas where population is growing at an average annual rate of about 4 percent, or roughly twice the national annual averages. Imports have increased in all countries mostly to satisfy this burgeoning urban demand. Nigeria alone imports some $1.3 billion of food annually.

Food production has held steady and in some cases declined because of various production constraints. Despite efforts to introduce modern inputs and methods, farming remains predominantly traditional. For many crops such as upland rice in Sierra Leone and Liberia, production plateaus have been reached using traditional varieties and methods. But productivity has declined in many areas even with the use of modern inputs. In the semi-arid zones north of the forest, land has been used more intensively due to increased population pressure. Both the length and amount of land fallowed has decreased, as land tenure arrangements change and an economic pressures shift. In these areas, soil fertility has declined, productivity has

diminished, and much land has been ravaged by erosion. In Nigeria, for example, yields have declined over the last decade for maize, millet, and sorghum.

Inadequate and unreliable rainfall have further contributed to production decreases, causing average yields for grains to decline in the region. Periodic pest infestation have also been a factor in the declines, causing widespread damage in rice crops in Sierra Leone and Guinea last year, and for groundnuts and millet in Nigeria in years past.

The deterioration of agricultural production can also be traced to the lack of policy initiatives as well as to policies which have been ineffective and misdirected. Related to this has been the substantial outmigration from rural areas, particularly by young people. A shrinking and poorly educated agricultural labor force further constrains agricultural production.

Food and Agricultural Policies

All the West African nations stress the importance of the agricultural sector within their economies. Food self-sufficiency is an objective of most of the countries, although this goal is to be realized within differing time frames and by means of different policies. Many of the countries are already close to or at self-sufficiency for certain food crops and seek to maintain self-sufficiency, extend it to other food products, or create exportable surpluses. With rapid population growth and changing consumption patterns, these may be difficult aims to achieve.

While stated policies for increasing food production reflect a growing commitment to the agricultural sector, the implementation of these policies is often thwarted by poor administration and changing government priorities. The

Government of Nigeria has had several programs promoting food self-sufficiency. Operation Feed the Nation (OFN) [12/] and the National Accelerated Food Production Programme (NAFPP) were introduced in the mid-seventies and designed to accelerate food production. By and large, these programs were unsuccessful and the gap between food demand and supply has widened. More recently, the government launched a "Green Revolution" food production program in order that the country become food self-sufficient by 1985, and a net food exporter by 1987.

In Ghana, food self-sufficiency was given top priority when Operation Feed Yourself was initiated in 1972. Despite this initiative, the decline in per capita food production has been significant. The new regime continues to stress the importance of increasing food production. For Benin, Cameroon, and the Ivory Coast food self-sufficiency is focused on rice since all three countries produce a sufficient amount of other staples in most years. Although rice is not their main food item overall, it is (along with wheat) becoming an important part of the urban diet. Rice is the staple food in Guinea, Guinea-Bissau, Liberia, and Sierra Leone; the latter is self-sufficient in most years. All four countries aim at maintaining or achieving rice self-sufficiency although there is no specific time-frame.

Land Tenure--Many governments in West Africa regard traditional land tenure systems as an impediment to improving agriculture. In most of these countries, efforts have been made to improve agriculture by introducing new production patterns that alter traditional farming practices and thus traditional land tenure systems (table 42). In Ghana, for example, in the early sixties, state farms were established for food crop production. The

structure of these farms was intended to combine the communal nature of African society with more modern economic practices and thinking, namely socialism, and the aim was to produce food on a larger scale and more efficiently than on small private holdings. These farms showed little success because of management and agronomic problems and because of mistaken assumptions about the willingness of farmers to work for the state on large enterprises. In Benin, cooperative farms were also started to increase the size of farm operations and production. These also met with little success. Guinea as well established and maintains communal production units which have affected some traditional land tenure arrangements, but the record of their progress is unclear.

Though these and other efforts had great appeal to politicians and planners, they failed to produce the intended results because they ignored the

Table 42--Typology of land tenure patterns, West Africa 1/

Country	Individual title	State farm	Controlled schemes	Private foreign-owner plantation
Benin	X	X	-	-
Cameroon	X	X	-	-
Ghana	X	X	-	-
Guinea	X	-	-	-
Guinea-Bissau	X	X	-	-
Ivory Coast	X	X	-	-
Liberia	X	-	-	X
Nigeria	X	-	-	-
Sierra-Leone	X	-	-	-
Togo	X	X	-	-

1/ Communal tenure land predominates.
X = Land tenure arrangement exists.
- = Land tenure arrangement does not exist or no information is available.

force and the sociological importance of the traditional farming and land tenure systems. Status, authority and lineage are all elements in the tenure system which also embodies the complex economic relationships characteristic of traditional culture. These systems have predominated because they fulfill specific economic functions, yet at the same time they have changed to fulfill newer functions and serve more recent needs. Traditional arrangements have been altered to allow for change.

But despite the predominance of these traditional tenure systems, planners are eager to introduce measures to transform their agricultural systems. Many officials believe the traditional systems dictate that too much land remain fallow, depriving some people of access to land and reducing potential production. Furthermore, they believe constraints on the sale of land also dictated in traditional systems prevent the consolidation of holdings and thus vitiate efforts to introduce mechanized farming methods. Many planners fail to recognize that traditional systems require land to lie fallow and restrict its sale not only for reasons dictated by customary law but for conservation purposes as well.

Nevertheless, policies have been enacted in many countries to register and title land, to release much of it for more ready sale. Liberia and Togo have undertaken such programs, and in Nigeria, the Federal Government is presently considering undertaking a program to assign title to land and keep records of its use. All of these efforts are seemingly important to the governments for tax reasons, and because officials assume that outright ownership will allow for land to be more freely transacted and thus induce increased production. However, in traditional systems, access to land and the right to use it are of

primary importance and, ownership is much less crucial. This is so because membership in a group ensures access to land, or some commercial arrangement can be made, and because improvements to the land and their resultant return belongs to the user. Proprietary rights reside with the larger group in any case. But many officials ignore this distinction since they assume ownership of land is a necessary condition for increasing farm production.

By ignoring the importance and the workings of the traditional systems, officials have neglected the fact that many of them have adopted to new conditions. Traditional arrangements have changed to meet new needs since population pressure and food production demands have increased. In every country there are areas where traditional land tenure systems predominate, while in other areas arrangements to rent or share crops or more freely exchange land have become the norm. In Togo, for example, nearly 50 percent of farmers rent some portion of the land they use, and in northern Nigeria renting of land is quite common. But in some cases, governments fail to realize that land tenure differs between regions and so continue to legislate on a national level.

In some cases, it happens that the officials who legislate land policy are the ones who can most easily benefit from it. If registration and settlement of land is the law, politicians can use their influence to acquire the land through purchase and sometimes through nefarious means. In Liberia, for example, paramount chiefs have sold land that is not fully theirs to dispose of, often to officials who intend to use it for purposes of speculation. More open sale of land does not always translate into more production and it is not always the small farmer who benefits from the national policies.

Producer Prices--Since most food crops are grown for subsistence and are highly dependent on weather conditions, producer prices (particularly official prices) have limited influence on aggregate output. The responsiveness of marketed quantities to changes in official prices is more apparent. Given an appropriate incentive, farmers might market a greater share of their produce to the official marketing agencies rather than through nongovernmental channels. In general, however, the proportion of marketed output (particularly that which is handled by official agencies) to total output is small, although there are variations by country and commodity.

Although government pricing policy is geared primarily to cash crops, certain countries have attempted to influence the production and marketing of foodstuffs. In certain years Benin, Ghana, the Ivory Coast, Liberia, and Nigeria, have established guaranteed minimum producer prices for selected commodities (table 43).

In Ghana, the Government established minimum prices for maize and rice in 1976 through the Food Distribution Corporation and Rice Mills Unit respectively. Farmers found it more profitable to sell on the open market. In early 1980, rice milling operations at state-run mills came to a virtual standstill because farmers could obtain double the minimum price outside official channels. More recently, Ghanian farmers expressed dissatisfaction with inadequate producer prices by decreasing acreage of food crops and refusing to harvest or deliver crops to market.

In the Ivory Coast, the situation is somewhat different. In 1974, the guaranteed producer price for rice was more than doubled. Producer response was strong and government mill and storage facilities were incapable of

Table 43--Producer price controls for food crops,
West Africa

Country and major food crops	Has official producer price	Has official monopsony
Benin		
Rice	X	-
Millet and sorghum	-	-
Maize	X	-
Roots and tubers	-	-
Cameroon	-	-
Rice	X	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Ghana		
Rice	X	-
Millet and sorghum	-	-
Maize	X	-
Roots and tubers	-	-
Guinea		
Rice	X	X
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Guinea-Bissau		
Rice	-	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Ivory Coast		
Rice	X	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Liberia		
Rice	X	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Nigeria		
Rice	X	-
Millet and sorghum	X	-
Maize	X	-
Roots and tubers	X	-
Sierra Leone		
Rice	X	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-
Togo		
Rice	X	-
Millet and sorghum	-	-
Maize	-	-
Roots and tubers	-	-

X = Policy or institution exists.
- = No policy or institution exists or no information available.

handling the surplus. Since then, prices have remained at the 1974 level. Furthermore SODERIZ, the official agency responsible for rice marketing and processing, cannot actually guarantee the official price to the farmers. Unless farmers can organize and pay for their own transport they must sell their produce to middlemen and receive perhaps half the "guaranteed" minimum. Consequently, less than one quarter of the rice produced ever reaches the SODERIZ mills or the Abidjan markets. [13/] It is generally agreed that the lack of an effective price support system has been a major disincentive to rice production and marketing.

The Liberian Government also attempted to influence the production and marketing of rice through a price support system. The inefficiencies of the marketing system resulted in poor farmer response. When the Government tried to increase the producer price and the consumer price in mid-1979, riots ensued and the proposals for increases were quickly shelved.

In 1977, the Government of Nigeria established a dual price structure for food grains and tuberous crops. On the one hand, guaranteed minimum producer prices (or Commodity Board buying prices) were introduced. However, these are only intended as fall-back prices since the Commodity Boards which offer these prices do not have monopoly jurisdiction. Since these prices tend to be well below the prevailing price on the free market, procurement by the Commodity Boards is necessarily low. Secondly, the Commodity Boards were authorized to procure grains for Nigeria`s Strategic Reserve at prices more in line with actual market prices. Misunderstanding about how this dual structure should operate led to its dissolution. Currently, the only price system is that of

the guaranteed minimum prices. There are no government-controlled producer prices for food crops in Togo or Cameroon.

Input Subsidies--In West Africa, as in other regions, the use of modern inputs for food production is very limited. Most farmers produce for subsistence using traditional methods of cultivation. With a few exceptions, notably in Nigeria, the availability of inputs and input subsidies has been generally geared to larger farmers and to important cash crops. Inefficent administrative structures and limited financial resources have been serious constraints on the distribution, availability and use of inputs.

Fertilizer is the principal input which is subsidized, accounting for the bulk of all subsidy payments. In Nigeria, the subsidy is initially borne by the Federal Government and then by individual states with the total subsidy reaching as high as 85 percent of the farmgate price. The Federal Ministry of Agriculture recently reduced the subsidy element to 50 percent although prices paid by farmers did not increase accordingly due to higher subsidies at the state level.

The actual subsidy element for fertilizer in Ghana has varied between 24 percent and 63 percent. Taking into account overvalued currency and failure to charge the full distribution costs, the subsidy may be even higher. In Ghana, as in many other countries, the benefits of the program have been confined to a small group of farmers generally those who practice mechanized cultivation (including rice). An additional problem associated with subsidized fertilizer in Ghana is that it tends to be smuggled across national borders with the result that the government is actually using scarce foreign exchange to stimulate agricultural production in neighboring countries. The

previous overnment was planning to phase out fertilizer subsidies over a 3-year period beginning in 1978. It is not known how the new Government is going to deal with this issue.

Subsidies are only available to a limited number of rice farmers in Liberia. The Government had focused initially on large scale rice plantations but now appears to be directing attention to small-scale production. New production programs recognize the importance of inputs and an improved seed-fertilizer package designed to reach 80 percent of upland rice producers is currently under consideration.

Mechanization is favored in certain countries and subsidized accordingly. Mechanized services for land clearing and preparation and harvesting of rice are offered through Ghana's Ministry of Agriculture and subsidized up to 78 percent. The current Government has, however, stated its intention of emphasizing small-scale production. In Nigeria, certain mechanized services are subsidized. Most important are the tractor hire units (THUs) which are subsidized up to 70 percent of cost. Many contend that this has encouraged the use of capital-intensive methods of production and accelerated rural-urban migration. Present Government policy aims to phase out the THUs.

Credit--Agricultural credit is available to farmers through non-institutional and institutional sources. Most smallholder credit comes from non-institutional sources despite the generally high interest rates since the timeliness, convenience and informality of these loans make them more attractive to small farmers. As an example, Nigerian traders offer short-term credit to Beninese farmers. Non-institutional credit can take the form of

payment in kind as in Sierra Leone where farmers must pledge a portion of their rice crop in order to borrow money.

Institutional credit for small-farmers, and particularly for those producing food crops, has been very limited, although many governments are attempting to increase the availability of such credit. In Ghana, previous policies emphasized mechanization of large farms, and little credit was available to the small farmer using traditional techniques. It was estimated that less than 10 percent of farmers received institutional credit and only one-fifth of that credit went to farmers with landholdings of less than 4 hectares.

In Nigeria, the main beneficiaries of loans from the National Agricultural and Cooperative Bank are large scale farmers. Recent initiatives to expand credit availability include the Agricultural Credit Guarantee Scheme in Nigeria whose purpose will to be provide guarantees for agricultural-specific loans by any bank, and the recently reorganized rural development agencies in the Ivory Coast whose mandate has been extended to food crops and to the provision of sector supporting services such as agricultural credit.

<u>Research</u>--The problems associated with food crop research are typical throughout most of Sub-Saharan Africa. While substantial investments and progress have been made in cash crop research, the generally low priority accorded to food crops, the limited trained personnel, and the weak links between research centers and farm application have all constrained the food crop oriented research and the application of results. Limited rural infrastructure and the lack of adequate and effective extension services are additional constraints.

In francophone West Africa, most of the research activities are carried out by specialized French institutes under government supervision. The Institut de Recherches Agronomiques Tropicales (IRAT), is concerned with grains, yams, cassava, groundnuts and sugar. In the Ivory Coast, attempts are being made to link up basic and applied research under the aegis of the regional development agencies. Until now there has been no mechanism to transmit experimental results into a useful package for farmers. In Cameroon and Benin, the respective governments are attempting to gradually replace the French-run research institutes with indigeneous units. The Beninese government has created a series of 12 research units for different crops designed to focus on country-specific production problems. Research results should be transmitted to the farmers through the regional agencies.

In Ghana, research responsibilities are divided between the universities and the Council for Scientific and Industrial Research (CSIR). The CSIR undertakes a wide range of research functions. However, research suffers from a lack of coordination among the various research institutes and between the latter and the Ministry of Agriculture with the result that there is often duplication of efforts and lack of clear priorities. The new Government`s emphasis on agriculture and on food production may ameliorate this situation.

In Nigeria as elsewhere there has been a lack of formal linkages between basic research at national centers and applied research and trials at the farmer level. The International Institute of Tropical Agriculture is carrying out certain research activities for the NAFPP. The aim of the NAFPP is to develop and formalize these links. The recently formed integrated agricultural development projects are designed to make research results available and to undertake field trials in a defined rural area.

Crop Procurement--Throughout the region, official marketing and pricing policies for agricultural production are directed toward the countries' traditional cash crops. For a number of reasons, these policies and the institutions with which they are associated have had minimal influence on food production and marketing. Of particular importance is the fact that most food production in this region as in others is of a subsistence nature. Much of the total output is consumed on the farm while varying amounts depending on the country and the commodity are traded locally. Marketed quantities may also be limited for other reasons as in Sierra Leone and Liberia where cultural practices have dictated that rice be kept on the farm for ceremonies or as stocks against future shortfalls.

Another reason of perhaps equal importance is that the official marketing system, including associated structural problems such as inadequate transport infrastructure, high transport costs, and lack of storage facilities has provided little incentive to the farmer. The inflexibility of their pricing structure, their scarce financial resources, and their insufficient number of buying agents preclude effective or substantial market intervention by state-run agencies and commodity boards.

The bulk of marketed foodstuffs is channelled through the traditional marketing system. In several countries, the farmers do not have other options for all or some of their crops. Where official agencies do have partial responsibilities for marketing food crops, they tend to offer prices which are substantially lower than those on the open market. Farmers are thereby encouraged to circumvent official channels and receive better renuneration from private traders. This is the case for rice farmers in Ghana who can

receive almost double the price for their produce on the open market than they can through the Rice Mills Unit (RMU). Similarly the purchase system of the Liberian Produce Marketing Corporation has done little to encourage rice marketing.

In certain countries, however, farmers are required to sell their produce to the official marketing agency. The production brigades in Guinea must sell their output to the regional trading enterprises, and as a result, the quantities of officially marketed foodstuffs has risen significantly. Until recently, private farmers (those who are not part of production brigades) were also required to sell part of their output to the state. These farmers are now encouraged to do so although not required. The Government is offering farmers a range of consumer foods in exchange for their agricultural output.

The Government of Cameroon established the Mission de Développement des Cultures Vivrières, Maraichères et Fruitières (MIDEVIV) in an attempt to organize food crop marketing. This agency, like the RMU and the Food Distribution Corporation in Ghana has been unable to fulfill its tasks and presently handles only a fraction of marketed output. The bulk of domestic paddy is collected by the Société d'Expansion et de Modernisation de la Riziculture à Yagoua (SEMRY) in northern Cameroon. Some rice is distributed in the general area where it is produced and exported to neighboring Chad and Nigeria. It appears however that most of the rice collected remains in SEMRY warehouses since high transportation costs, quality preferences and ineffectual import controls preclude the marketing of domestically produced rice to urban areas in the south. Although there are sharp regional

variations, Cameroon has a generally well-developed private marketing network.

Market participation in Nigeria is unrestricted and the marketing of food crops takes place within a complex network of producers linked by small localized markets. The Commodity Boards for grains and tuberous crops and other agencies with marketing responsibilities operate a minimum pricing system, and thus tend to be residual buyers of the farmer's commodities. Infrastructural, financial, and managerial constraints preclude substantial market intervention on their part.

In Benin and the Ivory Coast, regional development agencies perform certain food marketing functions. A recent initiative in Benin was the establishment of the Régies d'Approvisionnement et de Commercialisation (RACs), which were to function as regional marketing agencies and "to insure an adequate supply of foodstuffs at reasonable prices to urban consumers." These agencies have not proved to be financially viable and have since been disbanded.

In the Ivory Coast, some domestic paddy is handled by the Office de Commercialisation des Produits Agricoles (OCPA) which took over from the Société pour le Développement de la Riziculture (SODERIZ) in 1977 (table 44). The activities of OCPA are severely constrained by the lack of financial resources and support services which would allow for an effective collection and pricing system. At present, the agency cannot even ensure that farmers receive the minimum "guaranteed" price. Rice farmers are also penalized in Guinea-Bissau, where the Ministry of Commerce has been unable to buy up all their surplus production.

Table 44--Major marketing institutions for food crops, West Africa

Country	Marketing institutions	Acronym	Food crops covered 1/
Benin	Centre d`Action Régionale pour le Développement Rurale	CARDER	All
	Régie d`Approvisionnement et de Commercialisation	RAC	All
Cameroon	Mission de Développement des Cultures Vivrières Maraîchères et Fruitières	MIDEVIV	All
	Office des Céréales	OC	All
	Société d`Expansion et de Modernisation du Riz à Yagoua	SEMRY	Rice
Ghana	Food Distribution Corporation	FDC	Maize
	Rice Milling Unit	RMU	Rice
Guinea	Entreprises Régionales de Commerce	ERC	All
Guinea-Bissau			
Ivory Coast	Société pour le Développement de la Riziculture	SODERIZ	Rice
	Office de Commercialisation des Produits Agricoles	OCPA	Rice
Nigeria	Nigerian Grains Production Company	NGPC	All grains
	National Grains Board	NGrB	All grains
	Nigerian Tubers and Roots Crop Board	NRCP	Roots and Tubers
	Nigerian Root Crops Production Company	NRPC	Roots and Tubers
Sierra Leone	Sierra Leone Produce Marketing Board	SLPMB	Rice
Togo	TOGOGRAIN	--	All cereals

NA = Not available.

1/ The procurement responsibilities of marketing institutions vary among countries and actual procurement of commodities may vary from official procurement responsibilities.

Transportation--In most of West Africa, transport networks have traditionally been geared to the marketing of cash crops. The existence of port facilities and connecting road and rail systems have been instrumental in this regard not only for the coastal countries themselves but also for their northern neighbors who depend upon this access for the bulk of their trade. 14/ However, the lack of adequate internal transport infrastructure has constrained food production, limited any potential price-response by the farmer, and impeded the marketing of foodstuffs. Roads, the predominant mode of transportation throughout the region, are generally inadequate. There has been a tendency to emphasize the construction of new roads rather than the maintenance of existing ones. Certain rural and outlying areas are isolated in the rainy season when roads become impassable; others remain isolated for topographical reasons.

At present, most food is consumed locally while varying amounts are marketed. As urban demand increases, greater marketed quantities of food will be needed as well as more intraregional distribution. The transportation system has an obvious crucial role in this regard.

In Nigeria, although there has been rapid development of interstate highways, there has not been a concomitant improvement in the expansion and maintenance of the rural road network. The relative paucity of roads makes the marketing of crops difficult. It is also a major cause for farmers having to depend historically on a few traditional primary marketing channels characterized by few buyers and inflexible purchasing schedules. Similarly Ghana competition is reduced because traders work in rigid geographical areas defined by available transport infrastructure.

In the Ivory Coast, a well-developed export-oriented transport system has been a major stimulus to rapid growth. However, the northern region has remained relatively isolated. In an effort to promote more regionally balanced growth, the government intends to allocate more funds to this region and specifically to basic infrastructure. In outlying areas of both the Ivory Coast and Ghana, farmers have inadequate access to rural markets and often are forced to sell their produce to middlemen at a lower price. In Ghana and Sierra Leone, an estimated 70 percent of farmers have to headload produce from their farms which implies that only small quantities of produce can reach the market. The improvement and extension of paths and feeder roads are critical to increasing access to producing areas and encouraging marketing activities.

Storage--The lack of adequate storage facilities is an important constraint to food production and marketing in West Africa. Limited capacity, particularly in rural areas, results in substantial post harvest losses and price fluctuations. Many countries are seeking to increase their storage capacity; however from available information which is available on specific projects, it appears that centrally-located stores are favored over storage capacity in rural producing areas.

In Benin, although centralized storage capacity only amounts to some 13,000 tons, it is at present underutilized. In Ghana, the Government is seeking to increase the country's storage capacity by some 52,000 tons. In previous years, lack of capacity has been a serious disincentive to producers. Good weather in 1974 produced a bumper crop of maize and brought the country back to self-sufficiency. Unfortunately the lack of storage capacity prevented the Government buying agents from purchasing surplus

production and farmgate prices declined accordingly. As a result, farmers reduced areas planted to maize the following year by 25 percent.

Throughout the region, it is assumed that most storage takes place at the farm level. These traditional farm stores vary by country and region in type and effectiveness. In Nigeria`s northern Savannah region, farm storage is relatively cheap and efficient, while in contrast, losses are very high in the more humid southern region. The Government of Nigeria is planning a Security Grain Storage Program with a 250,000 ton capacity as well as some smaller State level storage centers.

Trade--Apart from Nigeria, few countries in West Africa are major food importers. Many countries are self-sufficient in certain foodstuffs and are able to export to neighboring countries. Imports are on the increase however throughout the region, especially imports of rice and wheat destined for the urban areas (table 45). In Nigeria, despite efforts to increase food production and achieve some level of food self-sufficiency for certain crops, the country relies to an increasing extent on food imports. During 1973-78, food and other agricultural imports increased by some 450 percent. Even in the Ivory Coast, where imports of basic foodstuffs have actually declined on a per capita basis, rice imports account for some 40 percent of domestic rice needs. Given the fact that throughout the region wheat production is minimal or nonexistent, that domestic rice production in many countries is not consumed in urban centers, and that urbanization is increasing at very rapidly, these trends are likely to accelerate.

Food aid has not played a major role in the region. Most of the countries have limited PL 480 Title II programs. Ghana and Sierra Leone have small Title I programs.

Table 45--Import record and policies, West Africa

Country	Average annual food self-sufficiency ratio, 1976-78 1/	Average annual cereals imports, 1976-78 2/	Average annual P.L. 480 food aid, 1976-78 3/	Import restrictions 4/
	Ratio	--1000 Metric Tons--		Policy
Benin	87	21.3	4.1	NA
Cameroon	90	104.6	2.5	Quotas/licenses: rice, wheat
Ghana	84	211.9	15.0	Quotas/licenses: rice, wheat
Guinea	85	54.8	7.8	NA
Guinea-Bissau	NA	NA	6.1	Quotas: rice
Ivory Coast	75	243.3	0.4	Quotas/licenses: rice
Liberia	80	61.3	.6	Quotas/licenses: rice, wheat
Nigeria	91	925.0	.4	Quotas/licenses: rice, wheat
Sierra Leone	90	37.7	5/ 4.1	NA
Togo	100	NA	8.1	NA

NA = not available

1/ The food self-sufficiency ratio is calculated as:

$$SSR = \frac{\text{per capita production of cereals}}{\text{per capita consumption of cereals}} \times 100.$$

The SSR for each country is calculated using data from the U.S. Department of Agriculture, Global Food Assessment, 1979, Table II-9 and the Food and Agriculture Organization, Production Yearbook, 1978.

2/ Food and Agriculture Organization, Production Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

3/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources, Food for Development in Subsaharan Africa, March 1980. Statistics in this report were orginally from Food for Peace Annual Reports, Africa CP 1980 and other Food for Peace documents.

4/ Economics, Statistics and Cooperatives Service.

5/ Figure does not include $1.3 million worth of commodities for which the tonnage is unknown.

All of the countries maintain import controls for a variety of basic goods including certain foodstuffs. State agencies generally have monopoly authority for the importation of these goods, either undertaking transactions directly or through the intermediary of buying agents. Import controls are intended to stem the outflow of foreign exchange and provide incentives to domestic production of specified commodities. Fixed prices and margins as well as import licensing are used to enforce the import controls.

The Government of Nigeria has resorted to a variety of import restrictions on rice, including increasing import duties, instituting import licenses and quantitative restrictions and finally, actually prohibiting all rice imports. Rapidly increasing demand necessitated the relaxation of this final measure, and rice can now be imported under license. It is expected that substantial amounts will be imported by the state-run National Supply Company and by licensed private traders. An attempt was also made to curb wheat imports through an import-licensing system instituted in April 1979. This is not expected to substantially reduce the volume of imports since consumers demand remains very strong while domestic production is minimal.

In the Ivory Coast, authorized traders bid to supply the Ministry of Commerce which controls the flow of rice at fixed internal prices. Although there is strict control over such imports, there have not been quantitative restrictions. The level of rice imports has been rising rapidly and is expected to reach 200,000 tons in 1980. In Ghana, Liberia, Sierra Leone and the Cameroon, imports of rice and wheat are also subject to a variety of restrictions. In the latter, a specific aim of the government is to make domestic paddy competitive with imported rice, or at a minimum, not to have

the latter act as a disincentive to domestic production. Importers of rice are required to hold a certain percentage of their stocks in local rice. However, due to the greater profitability of transactions with imported rice, there has been a failure to enforce both the importers purchasing and selling of local supplies, with the result that most domestic paddy remains in the warehouses.

Exports

Cash crop export controls are in effect in most of the countries and serve primarily to safeguard the export monopoly of commodity boards and marketing agencies. Controls or prohibitions on the export of foodstuffs are operational at varying times to ensure adequate domestic supply, and to control the exportation of imported goods to neighboring countries.

Despite these controls, unofficial and illegal exports across national boundaries are substantial and on the increase. In certain areas, traditionally subsistence food crops are becoming important cash crops. Spurred on by rapid demand increases in Nigeria, large quantities of maize and other foodstuffs are traded across the border from Benin and Cameroon. In fact, it may be easier to supply the major cities in these two countries through imports while allowing grain produced in the northern regions to go to Nigeria. These transactions are very profitable to the farmers and could also be profitable to the respective governments of Benin and the Cameroon given the necessary infrastructure. The maize mill currently under construction in south-central Benin could facilitate such exports.

Table 46 -- Selected indicators, West Africa.

Country	Population, 1977	--Urbanization-- Percentage of total population, 1977	--Urbanization-- Average annual growth rate, 1970-75	Per Capita GNP, 1977	Agriculture as percentage of GDP, 1977	Average annual growth rate, GDP, 1970-76	Average annual growth rate, per capita food production, 1965-79	--Transportation-- Total roads	--Transportation-- Paved roads	--Transportation-- Rail roads
	Million	---Percent---		U.S. dollars	---Percent---			---Kilometers---		
Benin	3.2	NA	NA	200	32	2/ 2.0	-0.75	3,303	705	579
Cameroon	6.7	28	8.0	340	32	3.4	-0.71	28,940	2,127	1,173
Ghana	10.5	33	5.1	380	39	0.4	-2.56	32,200	6,084	953
Guinea	4.6	17	6.2	220	32	5.3	NA	7,604	4,949	805
Guinea-Bisseau	.9	NA	NA	280	NA	NA	NA	3,218	418	0
Ivory Coast	5.1	35	9.3	690	1/ 25	6.5	2.20	45,600	2,461	657
Liberia	1.8	32	5.6	420	31	2.7	0.80	7,952	603	499
Nigeria	66.5	18	4.6	420	34	6.2	-0.84	107,180	25,180	3,505
Sierra Leone	3.1	23	5.6	190	40	1.9	-0.60	7,389	1,148	84
Togo	2.4	16	5.4	300	23	3.1	-1.36	7,000:	1,231	442

NA = Not available.
1/ 1976 data.
2/ 1970-76 data.
Sources: See Appendix tables

Central Africa

Central Africa is well-endowed with natural resources. All the countries except the Central African Republic produce petroleum. Angola and Gabon are major petroleum producers. Zaire is a leading producer of copper, cobalt, and diamonds. Angola and the Central African Republic also produce diamonds. Besides significant deposits of gold, managanese, uranium, and iron ore, the region has great potential for hydroelectric power. All the countries have unused arable land for greater crop production.

Except for Gabon with its $5,000 per capita GDP, incomes in Central Africa average less than $500. For political and economic reasons, the other countries have not been able to achieve sustained economic growth. Zaire and the Central African Republic spent heavily on prestige projects that have resulted in almost no increase in incomes, and lower copper prices in recent years actually held back economic growth in Zaire. The civil war, the destruction of the colonial institutions, and flight of managers and skilled workers in Angola after independence in 1975 reduced economic activity in that country by about 50 percent. As a result, Angola's exports of coffee, diamonds, maize, cotton, and sisal slowed to a trickle, and only the earnings from offshore petroleum paid for the imports essential for keeping the government and the economy afloat. Angola became a net food importer for the first time in 1975, and has continued to be dependent on food imports. Though Gabon's annual exports of $1.3 billion in petroleum and mineral products brought prosperity to the urban areas, relatively little of this has been invested in agriculture.

Food Production Record

All Central African countries are now net food importers although Angola and Zaire formerly were exporters. Angola exported substantial amounts of food until 1973 when 120,000 tons of maize were exported as well as lesser amounts of bananas, beans, sugar, cassava, palm oil, and even meat. Earnings from these exports more than paid for imports of wheat, malt. dairy products, and olive oil. Coffee, the principal cash crop. brought $203 million in foreign exchange, second only to petroleum. Angola's agricultural production declined by 50 percent after 1974, and has not yet recovered. In 1979, food imports included 200,000 tons of maize, 100,000 tons of wheat, and large amounts of rice and other foods. Coffee, the only significant agricultural export in 1979, was at a third of its former level.

Zaire was a net food exporter until 1960. A sharp decline in food production in the early sixties was later reversed, but since "Zairianization" in 1974, total agricultural production again declined, and subsistence food production has barely kept up with population. This has resulted in increasing imports of wheat, rice, and maize to supply the cities. Imports of these three commodities totaled about 365,000 tons in 1979. Even so, the average daily per capita caloric intake was only 83 percent of that required for good health.

In the other countries, agriculture was neglected for many years. Emphasis in the Central African Republic was on the export crops cotton and coffee; only a small part of the food crops reached commercial channels. In Congo and Gabon, the young people, most of whom have received at least an elementary education, do not want to work in agriculture. They have migrated

to the cities and food production has been barely enough to feed the people remaining in the rural areas. Both countries have substantial earnings from petroleum, and have found it easier to import wheat and rice to feed the urban dwellers rather than develop production.

Food and Agricultural Policies

Each Central African country has at one time or another stated the aim of increased food production. Angola and the Central African Republic are the only ones with a declared goal of food self-sufficiency. Angola is far below this goal but the Central African Republic would require relatively small increases in food production to become self-sufficient. Zaire and Congo have accorded priority to agriculture; Zaire wants to produce more cassava, maize, and rice to reduce imports of wheat, maize, and rice. The Government of Congo, after years of investment in large capital-intensive state farms, decided in late 1977 to begin putting resources into private farms. Gabon, which in recent years has imported 90 percent of its commercial food needs, wants to expand agricultural production in preparation for the day when petroleum runs out. Gabon's policy is to develop plantation type production of export crops such as palm oil, rubber, and sugar. Rice has been identified as the most promising food crop to develop for import substitution.

Despite espoused policies of increasing food and agricultural production, the actions of the governments of the Central African countries have often discouraged it. The implicit policies in Gabon, Congo, and the Central African Republic all resulted in neglect of the traditional food producers. An example of how government policies outside of the agricultural sector may inadvertently reduce crop production occurred in Zaire early in 1980. On

Christmas 1979, the government called in the 5 and 10 zaire notes which were then the principal medium of exchange in the markets. Each holder of the old notes was limited to exchanging 300 zaires for new notes within a period of only a few days. As a result, those living outside the urban areas without immediate access to a bank were left with worthless old notes. One of the results was a sharp decline in food prices, a disincentive to producers.

Land Tenure--Millions of small producers in the region derive the control of their land through their customary rights as members of a tribe or clan. During the colonial era, some of the land was taken out of this traditional tenure and deeded to Europeans for commercial farms and plantations, principally for producing export crops. In Angola, there about 4,000 of these farms ranging in size from large coffee plantations to much smaller diversified farms produced some food crops such as maize and potatoes. After independence when the farms were abandoned by their owners, the government turned them into state farms. Production on these farms has remained below former levels.

Commercial farms in the Congo were also operated by the state, but likewise with little success. In Zaire, the commercial farms were given to Zairians and continued under private ownership, but such a sharp decline in production resulted that the government took them over with no better results. Finally they were offered back to their original owners as joint ventures.

Only a few experiments have been made to adapt traditional tenure to modern production. The paysannat system in Zaire, which organized the small private farmer for commercial production, was not continued after

independence, though small holder projects by the World Bank and AID are similar in some ways. Angola is committed to organizing the small producer into cooperative farms, but problems with the commercial farms and the opposition or apathy of the peasants have slowed collectivization. In 1980 there were 296 production cooperatives with about 50,000 members; the total number of farms was 1.2 million. But there were 3,521 peasants associations with 418,000 members; these did not require collective production. The Government of Congo also wants to organize the private producers into cooperatives but the program is only beginning. In Central African Republic and Gabon, traditional tenure has not been touched (table 47).

Producer Prices--Some type of producer price control has been a part of government policy in the Central African countries since colonial times (table 48). Government policy to fix low retail prices to favor urban people has had a depressing effect on producer prices. However, government control of prices was often not effective enough to overcome natural market forces. For example, in Zaire`s Eastern Kasai Province in the late seventies competition among truckers to buy maize from the producers was so intense that it pushed maize prices to as much as $0.65 per kilogram, when the official producer price at the time was only $0.10 per kilogram. Of course, only the producers accessible to the roads benefited from the high price.

Low prices for commercial crops have been easier to enforce because the producers are larger. They keep accounts and records that are open to government inspectors who check the prices. For example artificially low prices set by the Government of Zaire for palm oil over a long period caused

Table 47: Typology of land tenure patterns, Central Africa 1/

Country	Individual title	State farm	Controlled schemes	Private, foreign-owned plantation
Angola	-	X	X	-
Central African Republic	X	-	-	X
Congo	X	X	-	-
Gabon	X	-	-	X
Zaire	X	-	X	X

1/ Communal land tenure predominates.
X = Land tenure arrangement exists.
- = Land tenure arrangement does not exist or no information is avaiable.

the decapitalization of the plantations and led to a decline in production from 245,000 tons in 1959 to 136,000 tons in 1979. Exports of palm oil ceased in 1979 after declining from a high of 183,000 tons in 1959. Palm oil in the past was Zaire's major agricultural export, but currently the entire production is consumed domestically both as the principal edible oil and as a flotation agent in mineral processing.

Inputs, Credit, Extension--Up to now, modern inputs, credit, and the extension services in Central Africa have reached mainly the large commercial farms producing the export crops, palm oil, coffee, and rubber. Of the more than 2 million farm families in Zaire, less than 50,000 have been able to use machinery, fertilizer, and credit, or receive the help of technical advisers. These have usually been the ones included in certain development projects financed by foreign donors. Examples are the U.S. AID smallholder maize project in northern Shaba, the World Bank maize project in eastern Kasai, and the CIMMYT improved varieties project in eastern Shaba.

Table 48-- Producer price controls for food crops,
Central Africa

Country and Major food crops grown	Has official producer price	Has official monopsony
Angola		
Rice	X	X
Wheat	-	-
Millet and sorghum	-	-
Maize	X	X
Roots and tubers	X	X
Central African Republic		
Rice	X	-
Millet and sorghum	-	-
Maize	X	-
Roots and tubers	X	-
Congo		-
Rice	X	-
Maize	X	-
Roots and tubers	X	-
Gabon		-
Rice	X	-
Maize	X	-
Roots and tubers	X	-
Zaire		-
Rice		-
Wheat	X	-
Millet and sorghum		-
Maize	X	-
Roots and tubers	X	-

X = Policy or institution exists.
- = No policy or institution exists or no information is available.

In pre-independent Angola, the government provided machinery, credit, and extension services through a number of "institutes," each responsible for a different set of commodities. Since 1974, the lack of security in the countryside and the flight of the technicians and professionals has made it difficult to continue the same services. Government policy is to put

increasing resources into agriculture, but the need is so great that even with Cuban and East European help, inputs and extension have not recovered to pre-1974 levels.

Research--Zaire and Angola had significant research programs when they were colonies. The experiment station at Yangambi near Kisangani was one of the world's leading tropical research facilities until 1960. The emphasis was on export crops. In Angola, research was focused on coffee. Little research is not being conducted in the central African countries, and what there is, almost all is managed by international organizations such as FAO and CIMMYT. The focus of this research has recently changed to food crops.

Crop Procurement--Marketing structure ranges from complete state control in Angola to private trade in Gabon and Zaire (table 49). The Congo has established two organizations to market farm production. One, the Office des Cultures Vivrières is involved in every stage of cassava, rice, maize, and groundnut production from supplying the inputs to marketing the crop. The other, the Office National du Commercialisation de Produits Agricoles, has the monopoly on buying and exporting coffee and cocoa, but also buys and sells rice, palm products, and vegetables.

Before independence, Angola had about 2,000 rural centers, each with at least one general store and a weekly market. The traders often paid good prices for maize and other commodities in order to sell high profit goods such as radios and tools to the peasants. Now all marketing functions are performed by the state, but state stores have been unable to take the place of the private traders. The inability of the state to perform successfully all the marketing functions has encouraged black markets. In the other countries,

private traders market food commodities. Zaire unsuccessfully experimented with marketing boards early in the seventies. In that country, the number of private traders is still below that which existed before "Zairianization," when hundreds of expatriates who provided the marketing functions where forced to turn their businesses over to Zairians who in most cases were unable or simply did not want to continue the services.

Transportation--The transportation system in most of Central Africa is inadequate for bringing production from farm to market. Food is not being produced because there is no way of bringing it to the market. In many cases it is easier to import rice and wheat than to transport maize and cassava from the rural areas to the cities. Zaire had at one time an adequate road network and has many navigable waterways, yet inadequate transportation is the main constraint holding back increased food production. The existing roads reach only half the population, and only 2,700 km are paved. Unpaved roads are impassable or at least difficult to traverse during at least part of the year in a region where annual rainfall is 1,000 mm or more. Though several projects have centered on road improvement and the Mobutu Plan assigns more than half of all public investment to transportation, roads and bridges have continued to deteriorate. Few new bridges have been built. The lack of repair parts for trucks and boats and the shortage and high price of fuel have reduced the roads use and diminished the effectiveness of the waterways. The 4,900 km of railways have little importance for food crops since they are mainly used to haul mineral exports.

Angola had the best road and rail network in the region before 1974. About 12 percent of the roads were paved, and the three important railroads

Table 49--Major marketing institutions for food crops, Central Africa

Country	Marketing institutions	Acronym	Food crops covered 1/
Angola	National Company for Purchase & Distribution of Agricultural Products	ENCODIPA	All
Central African Republic	Societe Industrielle des Produits Alimentaires et Derives	SIPAD	NA
Congo	Office National du Commerce	OFNACOM	NA
	Office National de Commercialisation de Produits Agricoles	ONCPA	Rice 2/
	Office des Cultures Vivrieres	OCV	Cassava, rice maize 2/
Gabon	NA		
Zaire	NA		

NA = Not available.

1/ The procurement responsibilities of marketing institutions vary among countries and actual procurement of commodities may vary from official procurement responsibilities.

2/ Handles other food crops and/or cash crops.

were well situated to haul crops. The Benguela Railroad traversed the maize growing central plateau and moved the maize to the port at Lobito. Most of the bridges were destroyed during the war of independence, but Cuban construction brigades have rebuilt them. The transportation system seems to be in fair structural condition, although guerrilla activity prevents full use

of the Benguela and Mocamedes railroads, and makes the roads in the center and south unsafe.

The rural areas in the Central African Republic, Congo, and Gabon have few good roads. Public spending has focused on show projects in urban areas. The poor condition of the roads is a result of the lack of interest in agriculture.

Storage--The little commercial storage that exists in Central Africa was built to accommodate coffee and other export crops. Angola had storage facilities in 1974 for more than 100,000 tons of maize. Wheat elevators at Matadi (Zaire) have a storage capacity of 14,000 tons and can handle 10,000 tons per month. Except for these two, the region has no significant facilities for grain storage.

Trade Policy--Trade policies in all four countries changed frequently and are *ad hoc*. In general, all the governments have favored grain imports to fill a large part of urban needs. Petroleum, mineral, or coffee exports have earned enough foreign exchange to pay for grain imports. The exception is Zaire in recent years where the low price of copper and the high cost of debt service have constrained imports.

Grain imports in Angola and Congo are made by the state. In the other countries trade is private; a major U.S. based grain firm imports and mills Zaire`s wheat, and the large mining company GECAMINES imports most of its maize (table 50).

Table 50--Import record and policies, Central Africa

Country	Average annual food self-sufficiency ratio, 1976-78 1/	Average annual cereals imports, 1976-78 2/	Average annual P.L. 480 food aid, 1976-78 3/	Import restrictions 4/
	Ratio	--1000 Metric Tons--		Policy
Angola	NA	153.7	1.2	NA
Central African Republic	5/ 91	11.5	.8	NA
Congo	5/ 40	60.8	2.4	NA
Gabon	NA	27.6	.08	NA
Zaire	70	381.6	1.1	Tax on rice and corn

NA = Not available.

1/ The food self-sufficiency ratio is calculated as:

$$SSR = \frac{\text{per capita production of cereals}}{\text{per capita consumption of cereals}} \times 100$$

The SSR for each country was calculated using data from the U.S. Department of Agriculture, Global Food Assessment, 1979, Table II-9 and the Food and Agriculture Organization, Production Yearbook, 1978.

2/ Food and Agriculture Organization, Production Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

3/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources, Food for Development in Subsaharan Africa, March 1980. Statistics in this report were orginally from Food for Peace Annual Reports, Africa CP 1980 and other Food for Peace documents.

4/ Economics, Statistics, and Cooperatives Service.

5/ 1976-77 average.

Table 51-- Selected indicators, Central Africa.

Country	Population, 1977	Urbanization: Percentage of total population, 1977	Urbanization: Average annual growth rate, 1970-75	Per Capita GNP, 1977	Agriculture as percentage of GDP, 1977	Average annual growth rate, GDP, 1970-76	Average annual growth rate, per capita production, 1965-79	Transportation: Total roads	Transportation: Paved roads	Transportation: Rail - roads
	Millions	-- Percent --		U.S. dollars	-- Percent --			-- Kilometers --		
Angola	6.7	19	5.7	300	49	2/-10.4	-4.70	73,828	8,577	
Central African Republic	1.9	37	5.1	250	38	0.9	NA	21,950	290	
Congo	1.4	37	3.0	490	1/ 11	5.6	NA	8,246	555	
Gabon	0.5	20	NA	5,250	NA	NA	NA	6,929	459	
Zaire	25.8	26	5.4	130	1/ 25	1.9	NA	168,979	2,654	4,859

NA = not available.
1/ 1976 data.
2/ 1970-77 data.
Source: See Appendix tables.

East Africa

All East African countries are very poor, falling into the World Bank's low-income category (GNP per capita per year below $300). Three are classified among the world's 10 poorest nations and another is ranked eleventh. Agriculture dominates all the economies. There is very limited industrial development other than in Kenya and few mineral resources have been discovered or exploited. The level of urbanization is relatively low compared to other regions in Africa.

Warfare in Eritrea and the Ogaden has resulted in a massive displacement of Ethiopians. Somalia now harbors the world's largest number of refugees, estimated to be over 1.5 million people, (perhaps a third of Somalia's own population), and still increasing. Sudan has received many refugees from Uganda and Ethiopia. The situation in Uganda is still unstable as a result of years under Amin's rule and the liberation war, and Tanzania still keeps a large occupation army in Uganda.

Food Production Record

Over the last 10 years, most of the East Afr..an countries have not increased per capita food production, but none of the countries have been importing large amounts of food on a regular basis. Self-sufficiency, albeit at less than satisfactory nutritional levels, has more or less been maintained in recent years with the exception of the mid-seventies in Sudan, Ethiopia, Somalia, and Tanzania. (The major shortfalls that occurred at that time were primarily caused by drought.)

Unfortunately, the current food situation for most of East Africa is bad. Up to 5 million people may have been affected by food shortages in Ethiopia

due to drought and war, while Somalia has a huge food deficit for similar reasons. Tanzania and Kenya have less severe shortages both related to unfavorable weather and in Kenya to a large reduction in the producer price of maize in 1979 and other policy issues.

The present food crisis in East Africa is more widespread than previous shortages. The problem of lagging food productivity can be traced not only to adverse weather and political turmoil but also to agricultural and food policies.

Food and Agricultural Policies

All East African countries stress the importance of agricultural growth in their official pronouncements but vary considerably in actual policies. Food self-sufficiency, in different degrees and time frames, is desired throughout East Africa. The goal of food self-sufficiency has had relative success in the past but the governments may be underestimating the difficulties involved in meeting the goal. All the countries aim to increase export crop production for employment reasons and, more importantly, for foreign exchange earnings.

Administrative capacity is weak in most of the countries, while state involvement in the economies and agricultural sectors is high. Ethiopia is attempting to develop a centrally planned economy and inefficiency seems to be increasing in the transition. Somalia officially follows socialism but accepts some private enterprise. Kenya is a more market-oriented, capitalist economy but has a large parastatal component, largely a result of the British colonial legacy, as in Tanzania and Sudan. Tanzania leans toward a socialist system with ambitious equity goals. Uganda is chaotic and the future course of the country is still uncertain. Much of the critically needed skilled

manpower was lost during the Amin era when many people were killed or fled the country. Somalia and Sudan have considerable "brain drain" problems, losing skilled people to the Middle East.

Land Tenure--Most of the countries have had some type of land reform or state modification of traditional land rights (table 52). The most wide-ranging change was Ethiopia's land reform of 1975, which limited individual holdings to 10 ha. and abolished tenancy. The reform was primarily directed to ending exploitation under Africa's only large feudal system, but was also to reduce fragmentation. The long-run goal is collectivization. As an interim step, peasant associations were established to build a foundation for future producer cooperatives. State farms were established on the largest holdings confiscated during the land reform. More acreage is currently being allocated to this sector. Reaction to the reform was quite positive in the southern areas where landlords dominated. In the north, however, there was some hostility because nonfeudal family holdings were affected. Net effects of the reform on production are uncertain; increases in output immediately after the reform were largely due to favorable weather while later decreases are related to transport problems and other war related disruptions and drought.

Tanzania has had an extensive "villagization" program to consolidate settlements, facilitating provision of inputs, marketing, and welfare services. It took place within the Ujamaa framework, the Tanzanian philosophy stressing self-reliance and African socialism. Many people were moved, sometimes by force. There was also considerable peasant opposition to collective production and the government has deemphasized this in the

villagization process. Output decreased during the villagization but part of this drop can be explained by poor weather. The effects on farming practices, use of inputs, and incentives to produce are not yet clear.

Kenya's reforms took place within a capitalist framework and had two dimensions. One "Kenyanized" and subdivided many of the prime lands owned by Europeans. The other introduced private ownership into many communally-controlled lands. Output increased throughout this period, defying some expectations. Access to the land is still very crucial, given rapid population growth and the shortage of arable land. Some of the larger wheat farms are apparently being subdivided at this time.

Burundi has started a small, voluntary program to establish villages and also had a reform which abolished ubugererwa, a type of a traditional sharecropping system. Both of these have had marginal effects. Rwanda has also begun to experiment with regrouping.

Table 52--Typology of land tenure patterns, East Africa 1/

Country	Individual title	State farms	Controlled schemes	Private foreign-owned plantations
Burundi	-	X	X	-
Ethiopia 2/	-	X	-	-
Kenya	X	-	-	X
Rwanda	-	-	X	-
Somalia 2/	X	X	X	-
Sudan	X	X	X	X
Tanzania 2/	X	X	-	X
Uganda	X	-	-	X

1/ Communal holdings predominate.
2/ Some collectivized holdings exist.
X = Land tenure arrangement exists.
- = Land tenure arrangement does not exist, or no information is available.

Somalia and Sudan have resettled some refugees, but in Somalia resettlement has been very limited. Most of the people are pastoralists and Somalia had previously resettled many of its own drought-stricken nomads into fishing schemes. Sudan's vast expanse means that tenure questions are less severe than the rest of the region, and private large-scale farming is encouraged.

Producer Prices--Price policy decisions play a more important role in the production of cash crops than food crops within East Africa. The influence of prices on food output is limited by the traditional nature of much food production which is largely outside the price system. Determination of administered prices is further hampered by severe data problems, such as the lack of effective crop reporting, so that prices do not necessarily achieve the goals of the planners.

Nevertheless, official prices for food crops are quite influential in Kenya and Tanzania. In both countries, prices are announced in advance of the crop year, but they reflect neither regional differences nor seasonal changes. Official prices do not necessarily affect production as much as they affect the amount officially marketed. Only an estimated 10 to 30 percent of the maize crops are marketed through official channels. For a number of years, the price of maize in Tanzania was kept low, apparently in the belief that larger producers would benefit disproportionately from higher prices. In recent years, the price has been raised considerably to bring it more in line with world prices.

Two examples illustrate the potential and the difficulties involved in administering producer prices. Early in 1979, Kenya was faced with a maize

surplus which it could not manage profitably. Therefore the government reduced the price dramatically. Farmers responded by cutting back and in some cases substituting sugar cane. This price reduction coincided with unfavorable weather so that Kenya now faces shortages for the first time in years. Tanzania recently began to purchase millet and sorghum through official channels at favorable prices in order to stimulate production of these traditional crops which previously were only traded locally. Farmers responded positively and marketings exceeded expectations. In the absence of urban consumer demand, this output had to be sold abroad at a loss.

Producer prices for food crops in Uganda are not controlled whereas prices are controlled for cash crops. During the chaos of the Amin period, cash crop prices were low, stimulating more food production, mostly for subsistence. Neither Burundi nor Rwanda have meaningful official producer prices for foods, although both governments are beginning to intervene.

In Somalia, official prices are important and have been raised significantly this year. Low prices have been considered a key factor in lagging production. Prices in Sudan are not announced until harvest time, reducing their effectiveness. The role of price signals is also reduced in the controlled irrigation schemes, where tenant farmers' production decisions are heavily determined by crop-sharing requirements and water charges for certain crops.

Assessment of the producer price situation in Ethiopia is difficult. There have never been government price controls for food crops. Marketing was highly fragmented with private urban wholesalers probably having the most influence on price levels. The present Government is attempting to stabilize,

but not completely control, producer prices by using state marketing agencies to procure grain. So far procurement is below desired levels and prices are reportedly low (table 53).

Input Subsidies--In parts of East Africa, inputs for food crop production are subsidized through special package programs which are targeted for certain areas or groups of farmers. Although general subsidies for inputs, particularly fertilizer, have been used frequently, these inputs are more commonly applied to cash crops which offer higher returns than food crops.

The most significant use of subsidized fertilizer for food crops has been in Kenya for maize and wheat. However, the subsidies have recently been reduced because they mainly benefitted the larger producers. By contrast, Kenya's policy for hybrid maize seed has been to avoid subsidies. This is because the seeds represent a relatively small share of production expenses and charging the real cost encourages careful use.

The most important package programs in the region operate in Ethiopia and Tanzania. In both cases, farmers are provided with extension advice, credit, and modern inputs, mainly fertilizer and improved seeds. The World Bank sponsors the National Maize Project in Tanzania, which covers about 500 villages in high potential growing areas. In Ethiopia, the Minimum Package Program was originally designed to reach farmers living along the main roads of the country. Since the change of government in 1974, the program has been extended beyond these areas. Subsidies and other costs of the program are underwritten by a number of foreign donors.

Some mechanization is apparently subsidized directly in Ethiopia and Tanzania for the state farms. In Tanzania, this primarily applies to

Table 53--Producer price controls for food crops, East Africa

Country and major food crops	Has official producer price	Has official monopsony
Burundi	-	-
Roots and tubers	-	-
Maize	-	-
Pulses	-	-
Ethiopia		
Teff	X	-
Maize	X	-
Barley	X	-
Wheat	X	-
Sorghum	X	-
Kenya		
Wheat	X	X
Millet and sorghum	-	-
Maize	X	X
Roots and tubers	-	-
Rwanda		
Roots and tubers	-	-
Maize	-	-
Pulses	-	-
Somalia		
Sorghum	X	X
Maize	X	X
Sudan		
Wheat	X	-
Sorghum	X	-
Tanzania		
Rice	X	X
Wheat	X	X
Millet and sorghum	X	-
Maize	X	X
Roots and tubers	X	-
Uganda		
Millet	-	-
Maize	X	-
Roots and tubers	X	-

X = Policy or institution exists.
- = No policy or institution exists or no information is available.

large-scale wheat production. Sudan has encouraged private large-scale, capital-intensive production because of its availability of land and shortage of labor. Tax advantages and low import duties on mechanical equipment encourage investment. At present, Uganda`s most pressing need is for basic inputs and hoes are being subsidized.

Credit--Credit for food production is relatively undeveloped. The low level of purchased inputs and the lack of mechanisms for channeling credit are related to this botn in cause and effect. Without credit, farmers are unable to buy inputs; in the absence of effective demand, credit needs are not stressed. Although land charges are generally not applicable, as in most of Africa, credit to finance land improvements as well as to purchase inputs would be very useful in most places.

Where there are credit programs, they are geared to more prosperous farmers and to those growing export crops. In Kenya, credit has mainly benefited larger producers of wheat, maize, and dairy products. Many of these farmers got assistance under the Guaranteed Minimum Return scheme which provided short-term financing and underwriting of risks. However, this plan was ended in 1979 apparently because of poor repayment while other sources of credit were limited. This contributed to current shortfalls in output.

The Government now indicates that it is attempting to improve credit availability. Farmers who grow 10 acres of grain or more or who grow cash crops are eligible for loans from the parastatal Agricultural Finance Corporation. The Kenyan Farmers Association, a leading cooperative is another important source of credit for many commercial farmers. More efforts are being made to reach smallholders, who grow 2 to 10 acres of grain, by

increasing credit funds through cooperatives. In the past, obstacles to small farmer credit have been the collateral requirements and complex application procedures; it is not clear whether these problems have been addressed.

Farmers on Sudan's irrigation projects receive short-term credit related to the supply of materials and services by the management. The Agricultural Bank of Sudan seems oriented toward funding machinery and agro-industries. In Ethiopia credit was formerly geared for the landlords and large farmers. Some funds reach individual farmers through the Minimum Package Program, but the long-term goal is to provide credit to collectivized groups through service cooperatives.

In spite of the disruption in Uganda, there is still a small, working cooperative credit system which the Government has expressed interest in expanding. The bulk of credit in Tanzania appears tied to projects, funded by the Rural Development Bank, with a smaller proportion available directly to farmers and villages. In none of these cases is there an emphasis on credit for food crops rather than cash crops.

Extension--Common to all East African extension systems are problems of organization and training, lack of transportation and other resources, little relevant information to convey, concentration on larger, progressive farmers, and limited transmission of feedback from farmers to researchers. Particular countries reflect varying degrees of success but none have yet succeeded in creating an effective extension service. Without more attractive salaries and working conditions, the best qualified people will not be attracted to careers in extension. Another problem is that there have not been many dramatic innovations to spread. The diffusion of hybrid maize in Kenya was certainly

assisted by extension demonstrations, but it was largely a result of more informal transmission through friends and neighbors.

The diversity of conditions within East Africa necessitates locally tailored recommendations. Much extension work is devoted to improving management and cultural practices, yet mistakes have been made. The emphasis on planting pure stands of crops in some areas has been resisted by many peasants who more rationally practiced intercropping. In Kenya and Tanzania, improved crop varieties require early planting at the beginning of the rains. This is difficult for most farmers, given the yearly fluctuations in the onset of the rainy season and the problem of preparing the hard-packed, dry soils in advance.

Tree planting to combat erosion is being encouraged in Rwanda, Burundi, and Ethiopia, although the effectiveness of these efforts is not clear. Anti-erosion and crop rotation suggestions by agents in Rwanda have reportedly been resisted due to the peasants` association of these practices with the colonial era.

Attempts to regroup dispersed and scattered farmers in East Africa have been mentioned . Tanzania has also experimented with radio broadcasts targeted for discussion groups of villagers as another means of dealing with this problem. In view of the transportation problems in most of East Africa, it still seems likely that only farmers in the most accessible locations will be able to count on reliable extension visits.

Research--Typical problems in East Africa include an orientation toward cash crops, lack of local manpower, a high turnover of expatriates, low investment, little integration with the rest of the agricultural sector, and

the absence of location-specific, relevant research. In general there is a long period between starting research efforts and the discovery of useful findings. Kenya`s success in developing improved maize was based on a long-term commitment beginning in the colonial era. However, Kenya still has not established a strong, indigenous research staff due to better career opportunities elsewhere. Concentration of scarce resources on maize research may explain some of Kenya`s current production problems with wheat, neglected in recent years. Kenya`s researchers now state that they hope to deal with farming systems and marginal areas, reversing the long orientation toward single crops and higher potential areas.

Tanzania has made a strong effort to develop improved varieties of maize for its varied ecological regions and has had some success. The crucial link to extension remains a problem in Tanzania, suggesting that knowledge of improved techniques has not reached many farmers. The research situation in Ethiopia is not clear during the present transition to a new agricultural structure. There are plans to conduct research on state farms in various ecological zones. Like Ethiopia, Uganda had a sizeable amount of trained manpower but research capacity has largely broken down. Sudan`s research has long been centered in Gezira and concentrated on cotton; the Government has recently placed more emphasis on diversification of crops and has begun work on dryland farming. Research in Burundi and Rwanda is extremely limited and almost nonexistent in Somalia.

Crop Procurement--Compared to more developed marketing systems for export crops, food crop marketing in East Africa is less reliable and efficient, creating high risks for farmers. All the countries have some state

intervention but private, local marketing generally dominates. State involvement in marketing began in the colonial era but it often focused on export crops only. The most common form of intervention today is the marketing board (table 54). Other more indirect interventions such as establishment of crop reporting networks are not as well developed.

The most comprehensive state marketing systems and controls for food grains are probably Kenya`s National Cereals and Produce Board and Tanzania`a National Milling Company. Both control marketing margins at all levels. Yet even in these two countries the share of output entering official channels is low and illicit trading is important. Kenya bans interdistrict movement of grains through nonofficial means, which creates considerable enforcement expenses and tends to delay supply and demand adjustment. 15/ Input distribution remains in private hands in Kenya and under the state in Tanzania. When hybrid seed was introduced in Kenya, existing private merchants were employed to sell the seed, since this involved less administration and fewer delays. However, fertilizer distribution has been less successful largely due to its bulkiness. Input supplies in Tanzania are less dependable, hampered by transportation problems.

In Ethiopia the state recently started the Agricultural Marketing Corporation (AMC) for the purpose of stabilizing the market. AMC is procuring output from state farms and "minimum package" areas and distributing inputs. Two existing organizations, the Ethiopian Grain Board and Ethiopian Grain Corporation, have been strengthened to improve market regulation and supervision, market intelligence, and international trading in conjunction with the AMC. The general objective is to

Table 54--Major marketing institutions for food crops, East Africa

Country	Marketing institutions	Acronym	Food crops covered 1/
Burundi	Société de Stockage et de Commercialisation des Produits Vivriers du Burundi	SOBECOV	NA
Ethiopia	Agricultural Marketing Corporation	AMC	Major food grains
Kenya	National Cereals and Produce Board		Maize, wheat, rice, beans,
Rwanda	Office National pour Le Développement et La Commercialisation des Produits Vivriers et des Productions Animales	OPROVIA	NA
Somalia	Agricultural Development Corporation	ADC	Maize, sorghum 2/
Sudan			
Tanzania	National Milling Corporation	NMC	Maize, wheat, pulses, rice, cassava, sorghum, millet
Uganda	Produce Marketing Board		NA

NA = Not available.

1/ The procurement responsibilities of marketing institutions vary among countries and actual procurement of commodities may vary from official procurement responsibilities.

2/ Handles other food crops and/or cash crops.

maintain prices within certain ranges since it is realized that total control of the unwieldy system is impossible. By achieving a 50 percent share of the wholesale trade in grain, pulses, and oilseeds, the Government plans to drive down private marketing margins. Ethiopia's situation is somewhat unique because it was never a colony of a European power. Therefore most of the marketing arrangements associated with former colonies are absent. Land reform also ended the important role of landlords in procuring crops, opening the way for more state involvement.

Official markets in Somalia are provided by the Agricultural Development Corporation (ADC). Farmers are required to sell their surplus grain to the ADC. The Gezira Board and boards of other irrigation schemes in Sudan purchase some wheat but the staple crop, sorghum, mostly remains in private channels. Even in Burundi and Rwanda, where most trade is on a local level only, the states have tried to increase their influence. Rwanda sets official price levels although there is no action to enforce these. In 1978, Burundi established a state enterprise, <u>Société de Stockage et de Commercialisation de Produits Vivriers du Burundi</u> (SOBECOV), to purchase food crops and regulate the market. So far this has had little impact since private trade remains more lucrative.

Uganda's marketing system has degenerated due to more subsistence production and heavy illegal marketing and smuggling (<u>magendo</u>). The Produce Marketing Board has only negligible influence at present. The Commonwealth Team studying the Ugandan economy recommended that this board be abolished but the Government has decided to retain and presumably to try to strengthen it.

The East African governments have expressed concern about the low efficiency and weak management of these parastatal and state bodies. There appears to be considerable scope for streamlining and perhaps decentralizing these organizations. However, subsidized consumer prices in some of the countries have forced the marketing boards to run at a loss regardless of efficiency. Another problem is the national coverage of the boards which must extend operations to unprofitable areas of the countries which private marketers neglect.

Transportation--Weak transportation systems are major constraints on food production and marketing. Fuel shortages and escalating prices have further handicapped basic weaknesses. In Tanzania, for instance, oil imports consume half of the foreign exchange despite severe austerity measures cutting nonessential use. Sudan considers transportation to be its biggest problem, and this may well apply to others in the area as well.

Railways are important in Ethiopia, Sudan, Kenya, and Tanzania, moving a large portion of agricultural goods. Unfortunately, with the exception of the new Chinese-built Tazara line in Tanzania and Zambia, all the systems are very old, dating from early colonial days. Poor maintenance and equipment shortages are common. Furthermore, they were built to link the more privileged areas of the countries with seaports for export purposes rather than for internal needs. The Tazara line has opened up some isolated areas but these will require more feeder roads to tap their potential.

The three landlocked countries, Burundi, Rwanda, and Uganda, have very tenuous external routes through Kenya and Tanzania. At the best of times, transport is slow and costly. The recent fighting Uganda cut off Rwanda and

Burundi, necessitating airlifts of essential goods. This situation precludes much reliance on international trade in foodstuffs. It makes more sense to develop high value, low-volume exports such as tea and concentrate on food self-sufficiency, as is being done. Transportation within these countries is poor. Uganda's formerly good highway system has deteriorated to a miserable state and the number of vehicles available has declined by 80 percent over the last decade. Rough terrain hampers road development in Rwanda and Burundi and they both lack vehicles and have problems with fuel supplies.

Only Kenya is currently constructing many new rural access roads, but all the states would probably increase road building if they had the capacity. The large size of many of the East African nations, especially Sudan, means that transportation development is extremely expensive.

Storage--Post-harvest losses of crops and frequent damage to inputs are well documented in East Africa. Two of the World Bank's biggest projects in the region involve grain storage improvement in Ethiopia and Tanzania. Storage capacity is low both on the farm level and at higher levels in the marketing system. As a result, price fluctuations are very wide, at least in those areas where unofficial marketing dominates. Double transport costs are sometimes incurred in rural areas where grain is shipped out at harvest time and shipped back later because of a lack of storage.

The climate in Burundi and Rwanda allows for successive plantings of crops spaced out to reduce the need for storage, but storage is still a big problem. Rwanda is expanding storage capacity through cooperatives with the help of donor assistance. Tanzania, Kenya, and to a lesser extent Ethiopia have been building national strategic grain reserves to increase food

security. Kenya has 180,000 tons capacity, Tanzania is building a 100,000 tons reserve and Ethiopia somewhat less. Some long-term capacity may still exist in Uganda as well. These reserves are small, however, and can only be considered as beginning to safeguard against yearly fluctuations in output. Storage reserves are costly and this limits expansion.

The shortage of storage space constrains the working of price policy. The good maize harvests of 1978 in Kenya and Tanzania overtaxed the system, resulted in big losses, and put pressure on administrators to lower prices.

Trade--Compared to other regions of Africa, the volume of international trade in foodgrains in East Africa is not as high nor is there as much variation in trading arrangements. None of the countries are large importers or exporters of food in most years. However, imports have been increasing recently. The greatest amount of food inflows occurred in the early and mid-seventies in Ethiopia, Tanzania, Sudan, and Somalia when there were big shortfalls mainly related to the weather. In general, food imports have not dampened local production incentives. All the countries have had P.L. 480 aid, mostly under small Title II programs. Ethiopia, Tanzania, and Sudan have had larger programs. Major increases in P.L. 480 are underway in most of East Africa due to the present food crises (Table 55).

International grain trading is under state control in all the nations, but smuggling in border regions is widespread. The Government of Kenya has checked rice imports, effectively containing consumption, whereas Tanzania imports a great deal of rice to supplement domestic production. Both countries have been importing more wheat recently as demand increases and production falls, but imports are still restricted. Sudan has been the only

Table 55-Import record and policies, East Africa

Country	Average annual food self-sufficiency ratio, 1976-78 1/	Average annual cereals imports, 1976-78 2/	Average annual P.L. 480 food aid, 1976-78 3/	Import restrictions 4/
	Ratio	- - 1,000 metric tons - -		Policy
Burundi	100	30.5	3.1	NA
Ethiopia	5/ 98	70.3	18.5	NA
Kenya	102	6/43.1	3.1	rice, wheat
Rwanda	100	6.5	4.5	NA
Somalia	NA	73.9	12.2	NA
Sudan	99	88.8	7/ 5.9	NA
Tanzania	93	108.1	25.1	rice, wheat
Uganda	100	15.3	0.07	NA

1/ The food self-sufficiency ratio is calculated as:

$$SSR = \frac{\text{per capita production of cereals}}{\text{per capita consumption of cereals}} \times 100.$$

The SSR for each country was calculated using data from the U.S. Department of Agriculture, Global Food Assessment, 1979, Table II-9 and the Food and Agriculture Organization, Product Yearbook, 1978.

2/ Food and Agriculture Organization, Production Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

3/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources, Food for Development in Subsaharan Africa, March 1980. Statistics in this report were originally from Food for Peace Annual Reports, Africa CP 1980 and other Food for Peace documents.

4/ Economics, Statistics and Cooperatives Service.

5/ 1976-77 average.

6/ Kenya was a net exporter of grains during this period.

7/ Figure does not include $4.8 million worth of commodities for which the tonnage is unknown.

Table 56 -- Selected indicators, East Africa.

Country	Population, 1977	--Urbanization-- Percentage of total population, 1977	Average annual growth rate, 1970-75	Per Capita GNP, 1977	Agriculture as percentage of GDP, 1977	Average annual growth rate, GDP, 1970-76	Average annual growth per capita food production, 1965-79	--Transportation-- Total roads	Paved roads	Rail roads
	Millions	-- Percent --		U.S. dollars		-- Percent--		--- Kilometers ---		
Burundi	4.0	2	1.7	130	64	3/ 1.4	-0.01	7,800	300	0
Ethiopia	29.3	13	7.0	110	52	2.5	NA	10,724	3,323	1,014
Kenya	14.2	13	7.0	270	41	6.2	1.06	50,840	4,300	2,040
Rwanda	4.4	5	5.6	130	46	3.9	0.74	9,020	320	0
Somalia	3.3	27	5.0	110	NA	1.2	NA	13,540	1,900	0
Sudan	19.5	22	6.9	290	43	5.0	NA	10,550	600	5,470
Tanzania	16.4	10	8.5	190	1/ 44	4.5	-0.08	34,227	3,588	3,555
Uganda	12.1	11	8.5	270	54	2/-0.1	-2.80	6,763	1,934	1,216

NA = not available.
1/ 1976 data
2/ 1970-76 data
Source: See Appendix tables.

East African country with plans to become a large grain exporter. To become the "breadbasket of the Middle East," Sudan hoped to expand wheat production to reach self-sufficiency and then become a significant exporter by the early 1980s. High costs and the lack of a comparative advantage in wheat production have forced reevaluation and abandonment of this goal.

Export taxes on cash crops are important revenue earners throughout East Africa and do not discourage individual producers from producing food. On a higher level, policymakers would be hesitant to sacrifice any foreign exchange or tax revenue due to reduced exports, but this does not seem to be an implicit cost to greater food production in the region.

Regional cooperation within East Africa is poor. The breakdown of the East African community in 1977 ended important economic ties among the three members, Kenya, Tanzania, and Uganda. However, some efforts are being made to re-establish trade and increase cooperation once again. Both Somalia and Sudan have stronger trade links with the Middle East than with the other East African states to the south. Rwanda and Burundi maintain some trade with Zaire largely because of their common colonial heritage under the Belgians.

Southern Africa

Turbulence and change have characterized Southern Africa in recent years. Warfare has occurred in much of the region, two states have gained independence (Mozambique 1975, and Zimbabwe, 1980), and pressure is increasing on the neighboring Republic of South Africa to change its policies of apartheid and white minority domination. Because of a rich mineral endowment, the region has an important strategic position in the world economy. Unlike

much of Africa, nonagricultural activities such as mining in many of the countries and manufacturing in Zimbabwe are well developed.

Overall, Southern Africa has a relatively low population for a large land area. The populations of both Botswana and Swaziland are under 1 million, while those of Namibia and Lesotho just over 1 million. However, population pressure is a significant problem in the three smallest countries, Lesotho, Swaziland, and Malawi, and in two large states, Botswana and Namibia, that have a shortage of arable land. The level of urbanization is high for Africa, closely relately to mining and high off-farm wage rates. Zambia is the most urbanized Black African country, having nearly 40 percent of its people in cities. Botswana has one of the fastest growth rates in the world for its urban population--close to 12 percent.

Per capita income levels in five of the countries are higher than average for Africa. However, distribution is quite skewed toward small modern enclaves. Futhermore, four of the Southern African states, Malawi, Mozambique, Lesotho, and Madagascar, are among the poorest in Africa with 1977 per capita income levels of $140, $150, $240, and $240, respectively. Economic growth has been steadiest in Malawi and Swaziland during the last decade, in both cases led by agriculture. Zimbabwe had an impressive, diversified record of growth until severely disrupted by fighting in the last few years. Lesotho, Mozambique, Zambia, and Madagascar have had poor economic growth over most of this period, whereas the economy of Botswana, formerly stagnant, has been strongly bolstered by recent mineral exploitation.

Agricultural and economic development in the region has been seriously disrupted by a number of events. The recently ended guerilla war in Zimbabwe

also involved Zambia and Mozambique. Even Botswana, which was less directly involved, was affected. Much of its development budget had to be diverted to defense and refugee needs. The breakdown of veterinary services in Zimbabwe led to the spread of foot and mouth disease into Botswana, and resulted in suspension of cattle exports to Europe.

In addition to the hardships and damage from the war, Zambia and Mozambique suffered from the UN trade sanctions on Zimbabwe. Zambia had to find costlier, alternative sources for many imported goods and used less dependable and more expensive trade routes. Mozambique suspended the use of its ports and railways for Zimbabwe, losing valuable transit trade revenue. While the sanctions had obvious costs for Zimbabwe itself, the country successfully diversified and strengthened its economy in a number of ways and managed to circumvent sanctions to a considerable extent.

Fighting for independence in Mozambique, Angola, and Namibia also created a large number of refugees in the region. The effects in Mozambique were severe: in addition to war damage, there was much upheaval caused by the near total exodus of Portuguese and by some sabotage. Warfare continues in Namibia and in Angola , constraining development in the region.

Most of the Southern African countries have capitalist economies, with substantial amounts of foreign capital invested in the mineral sectors. There are a substantial number of modern profit-oriented agricultural enterprises in many of these countries . Mozambique and Madagascar are centrally planned socialist states and Zambia follows a somewhat ambiguous course mixing socialism and capitalism. As a result of UN trade sanctions, increased

isolation, and reduced foreign investment, state involvement in Zimbabwe's pre-independence, "free-enterprise" economy became very important. The future orientation of Zimbabwe is still uncertain; Prime Minister Mugabe favors socialism in the long run but so far has avoided major changes. Namibia's status is unique: it is a former German colony controlled by the Republic of South Africa (RSA) under an expired mandate from the League of Nations and United Nations. The economy is dominated by a large white minority population and by the RSA.

Aside from Mozambique, which was under Portuguese rule, Madagascar which was under the French, and Namibia, the Southern African countries were colonized by the British and have many administrative features in common. All the states face a serious constraint in the shortage of trained manpower. During the colonial period especially in Zimbabwe, Mozambique, and Namibia, the presence of white settlers gave rise to the problem. Botswana, Lesotho,and Swaziland were not viewed as settler states but were very neglected in terms of education. Since independence, educational development in Southern Africa except for Mozambique has been based on colonial models ill-suited to the actual needs of the countries.

All the countries except Madagascar have been heavily influenced either directly by mining or indirectly by providing labor to work in the mines in neighboring countries. Zambia is an extreme case of a mineral-led economy--copper provides over 95 percent of its export revenue. Overdependence on copper has made Zambia highly vulnerable to fluctuation in the world economy. Despite good potential there has been relatively little effort to promote agriculture, continuing a pattern which started as colonial

Ties to the Republic of South Africa

More than most regions of Africa, the countries of Southern Africa, excluding Madagascar, are linked together by trade and transportation connections. However, these links are mainly through the RSA. Food imports from the RSA are crucial to Botswana, Namibia, Lesotho, Swaziland, Mozambique, and Zambia. Lesotho is physically surrounded by the RSA and is almost totally dependent economically. The B/L/S countries (Botswana, Lesotho, and Swaziland) are part of a customs union with the RSA. Virtually all power from Mozambique`s Cabora Bassa dam is currently exported to the RSA and management of the country`s ports and railways is assisted by the RSA. Migrant workers are another aspect of this dependence.

The RSA wants to increase regional dependence while the black states try to reduce it. Trade and transportation links are viewed by the RSA as important safeguards against political isolation. In April 1980, the independent Southern African states, along with Tanzania and Angola, held the Southern African Development Coordination Conference to plan "economic liberation" from the RSA. This group is an expansion of the five "Front Line" states which had started meeting in order to work on the liberation of Zimbabwe. So far a commission has been set up to study improvements to regional transport and communications. Other commissions are planned to deal with a joint policy on food reserves, coordinating aid, and pooling resources for mining, energy, and agricultural development. However, the group clearly recognizes the need for "economic co-existence" with the RSA for the near future.

policy. Botswana has just started to exploit diamonds, copper, nickel, and other minerals but plans to use mineral revenues to finance agricultural development. Vast deposits of uranium, diamonds, and other minerals in Namibia dominate the economy and largely explain why the RSA is unwilling to loosen its control over the territory. Zimbabwe has valuable deposits of abestos coal, gold, chromium, and other minerials, but mining has been more balanced by agriculture and manufacturing. The role of minerals in Swaziland is declining as iron ore deposits are running low. However, this sector has already been overshadowed by the development of renewable resources--forestry and agricultural products.

Those countries with little mineral wealth, Lesotho, Malawi, Mozambique, and to a lesser degree Botswana and Swaziland sent migrant labor to the mines of the RSA. Some labor also goes to Zimbabwe. Lesotno is the most dependent on remitted earnings of these workers, who represent as much as 50 percent of the Lesotho work force. Because of growing unemployment in the RSA, future prospects for this labor migration are poor, meaning reduced foreign exchange earnings and more domestic unemployment.

One of the key effects of mining development has been upward pressure on wage rates and increased urban migration within many of the countries. This has led in turn to labor shortages in rural areas, hurting agriculture. Also, the mining sectors have usually received heavier investment than the agricultural sectors and, because of the dominance of foreign capital, a great amount of the profits have been sent out of the countries.

Food Production Record

Only two countries are usually self-sufficient in food: Malawi and Zimbabwe. Botswana, Swaziland, Lesotho, and Namibia import substantial proportions of cereals, in the range of 25-50 percent of consumption, and even more in bad years. These imports are largely used for urban areas. Both Mozambique and Zambia have been self-sufficient in their main crops in the past. Production has deteriorated in Mozambique since independence while Zambia`s ouput fell off in the last 2 years. Much of the region was affected by drought in 1980. Zimbabwe (which had been exporting up to 500,000 m.t. of maize per year) and Malawi are importing maize for the first time in many years. In addition to adverse weather, war-related disruptions account for current problems in Zimbabwe, Zambia, and Mozambique. However, deterioration in Mozambique is primarily a result of the departure of the Portuguese, who produced the bulk of food, marketed in urban areas. Madagascar was a net exporter of rice until 1970 but for at least 20 years rice production has not increased as fast as population growth.

As a region, Southern Africa could probably come close to self-sufficiency without the RSA, assuming that food production in Zimbabwe recovers. The case of Zimbabwe is quite interesting. Before UN sanctions were imposed, agriculture revolved around maize and tobacco, with Rhodesia the second largest tobacco exporter in the world, and there were some food imports. Isolation provided an incentive for self-sufficiency and diversification. In addition to tremendous increases in maize production, production of wheat increased from nil in 1965 to the export level by 1978.

Food and Agricultural Policies

The dualistic structure of agriculture presents a serious challenge to policymakers in Southern Africa. Most countries have rural development objectives and hope to improve conditions for small farmers comprising the majority of the populations. However, the modern sectors provide a reliable source of food and/or foreign exchange. Their production cannot be jeopardized even if their existence may conflict with other goals.

Most of the food-deficit countries--Zambia, Botswana, Swaziland, Lesotho, and Madagascar --explicitly state that self-sufficiency in their main foodstuffs is a medium or long-range objective. In the shorter run they want to reduce grain imports. These official goals have varying degrees of urgency and realism. Since independence in 1964, Zambia has repeatedly paid lip service to the need to diversify the economy away from copper and tap its rich agricultural potential. Less has been done in practice, however. The domestic terms of trade have been unfavorable to agriculture and limited rural development efforts have mostly failed.

Swaziland's economy has been strong and food imports are not a great burden. Prices for Swazi exports have been quite favorable so that importing food for the urban areas may reflect some comparative advantage. Similarly, Botswana's mineral revenue and beef exports provide a cushion for its grain imports. Lesotho's situation is more difficult, however, because it has fewer resources and imports a higher proportion of its food, which makes its agricultural goals more pressing. As part of its overall drive to decrease dependency on the RSA Lesotho's main agricultural objectives are to increase food production and make agricultural careers more attractive to its migrant mineworkers.

At independence in 1975, Mozambique's short-term objective was to revitalize agricultural production for both food and export crops and reach pre-independence levels by 1980. The initial strategy of heavy mechanization and concentration on developing state farms failed. Management and effective use and maintenance of equipment have been major problems. Current policy seems more practical and less ambitious, recognizing the need to increase production in the traditional sector.

Zimbabwe has followed a policy of economic self-sufficiency including food and agriculture since 1965, in response to its isolation from world trade. This has largely been achieved. Future policies are uncertain due to the change of government. Few changes appear likely in the short term with respect to agriculture, as evidenced by the appointment of a white commercial farmer as the Minister of Agriculture. The other food self-sufficient country in the region, Malawi, is concerned with improving the productivity of smallholders while diversifying their output to include more export crops. The degree of food self-sufficiency is being increased by building large, modern storage facilities for maize. Even in years of bad weather and shortfalls, as is the current situation, the country will likely remain self-sufficient. Malawi's successful record in agriculture reflects an unusually strong commitment to agricultural development on the part of the Government.

Uncertainty surrounds the direction of agricultural policies in Namibia. When independence is gained, it is likely to stress development of the subsistence sector. Overall self-sufficiency in food grains is a doubtful goal because of the high costs involved, given the shortage of arable land.

Land Tenure--Questions concerning land tenure policies are among the most critical issues in Southern Africa. The questions mainly concern access to

grazing land, the presence of white settlers or foreign interests, and increasing fragmentation of cropland.

The biggest problem is in Zimbabwe where unequitable land distribution was one of the main grievances that led to fighting. Overcrowding in the Tribal Trust Lands has contributed to overgrazing, fragmentation, and reduced crop rotation and fallow periods. In 1977, restrictions on Africans' buying land in prime areas were lifted but few Africans had the means to do so. There is now strong pressure to break up or collectivize large white farms, and the need to avoid a large influx of people to the urban areas. During the war, many white farms were abandoned or acreage in production was reduced, freeing up some land. Approximately 4.5 million ha. will probably be redistributed to Africans soon, but this is far from sufficient to satisfy demand. A great number of refugees and displaced persons, perhaps over 1 million, further aggravates the problem. Clearly there is a delicate balance between satisfying the expectations of the African population and meeting the needs for high production through the existing commercial sector. So far the new Government has been cautious, trying to avoid disruption. Over the longer run, there may exist more potential for smooth redistribution. A number of white farms were kept afloat in the last few years by heavy government subsidies. As these subsidies are removed and cheap African labor is no longer available, more white farmland may open up.

Mozambique continues to invest in state farms for ideological reasons, and perhaps more importantly, because these are considered the most practical means of maintaining production in the short run. Establishment of "communal" or "township" villages is being encouraged both for ideological reasons and to facilitate the provisions of rural services.

The tradition of communal grazing in Botswana, Lesotho, and Swaziland has led to considerable ecological damage and overstocking of herds. Botswana has taken measures to establish a more efficient land tenure system through the Tribal Grazing Land Program and other reforms. The formation of fenced leasehold ranches is now permitted and cooperative ranches for smallholders are encouraged. In Lesotho, no fencing of pastures is allowed and grazing on croplands is permitted after the harvest. There is little incentive to make any permanent improvements to the land. Soil erosion has become a serious constraint and the size of family holdings is decreasing. No policy actions have yet been taken to deal with this situation. Swaziland allows freehold tenure on nearly half of the country's land area, called Individual Tenure Farm Land (ITFL), while the remainder is communal land, allocated by the chiefs, known as Swazi Nation Land (SNL). Foreign ownership and absenteeism may encourage the Swazi government to buy some ITFL to add to the national holdings, but no provisions have been made to deal with overgrazing in communal areas.

Overall, Zambia has an abundance of land, but there is some land pressure in the more developed agricultural areas of Southern Province, where most of the large commercial farms are located. The government has announced that a commission will study land distribution issues there. No actions which would upset the security of tenure of the leading commercial farmers are likely.

Madagascar began to nationalize large plantations and foreign owned land in 1976. Some state farms and a few cooperatives have been started but traditional land rights still apply to most farmers (table 57).

Table 57--Typology of land tenure patterns, Southern Africa 1/

Country	Individual Title	State farms	Controlled Schemes	Private, Foreign-owned Plantations
Botswana	X	-	-	X
Lesotho	-	-	-	-
Madagascar	X	X	X	X
Malawi	X	-	-	X
Mozambique	X	X	-	X
Namibia	X	-	-	X
Swaziland	X	-	-	X
Zambia	X	X	-	X
Zimbabwe	X	-	-	X

1/ Communal land tenure predominates.
x = Land tenure arrangement exists.
- = Land tenue arrangement does not exist for no information available.

Producer Prices--The role of producer prices in determining production of food crops varies widely within the region. Government determination of prices occurs in all the countries, but in some there are alternative, private marketing channels with different prices (table 58). Low prices have been a major constraint in Zambia, which has a large urban sector and has subsidized consumer food prices. Low prices in effect have acted as a tax on producers and have contributed to the lack of interest in farming of many Zambians. Prices which are the same throughout the country and frequently late announcements of price levels have also been problems. The Government has recently raised prices substantially for maize, making them the highest in Eastern and Southern Africa. Nevertheless high costs of production, especially for commercial farmers, dampen the actual incentive effect. Wheat prices are very high but have little relevance because this crop is not yet adapted for local conditions. The responsiveness of smallholders to price

Table 58-- Producer price controls for food crops, Southern Africa

Country and Major food crops grown	Has official producer price	Has official monopsony
Botswana		
Maize	X	- yes-for export
Sorghum	X	-
Lesotho		
Wheat	X	-
Maize	X	-
Madagascar		
Rice	X	X
Malawi		
Rice	X	-
Maize	X	-
Cassava	-	-
Mozambique		
Rice	X	X
Wheat	X	X
Millet and Sorghum	-	-
Maize	X	X
Cassava	-	-
Namibia		
Maize	-	-
Mahangu	-	-
Swaziland		-
Maize	X	
Zambia		
Rice	X	-
Wheat	X	-
Millet and sorghum	-	-
Maize	X	-
Cassava	-	-

x = policy or institution exists.
- = No policy or institution exists or no information available.

incentives is demonstrated by increasing cotton production as a result of high prices, above world levels, and good supporting services.

Obviously production in Zimbabwe is strongly influenced by price levels since 90 percent of marketed agricultural output has come from white commercial farmers. However, direct subsidies to farmers and the availability of cheap labor have reduced the impact of prices somewhat. The price of maize, for example, has been relatively low for the region yet production has been very high. The price system, however, is an actively used policy instrument. Production of wheat was encouraged by high prices, at times above import parity. This year, because of a rare shortage, an incentive bonus has been offered for early delivery of maize.

Prices are reportedly low in Mozambique but these must be placed in wider context. The marketing system formerly revolved around small traders who left the country after independence. Attempts to build a nationalized system from scratch have led to serious inefficiencies, aggravated by extremely poor transportation. Much of the grain trade used to be done on a barter system, with farmers receiving consumer goods for their products. Considering the present lack of reliability and disruption, price levels are probably less relevant as indications of incentives than elsewhere.

In those countries with low urban populations and mainly subsistence production, producer prices may also have limited influence. Maize prices in Malawi are fairly low compared to neighboring countries. However, only 10 to 15 percent of total production is estimated to move through official channels. Prices at local rivate markets which are permitted do not appear to differ greatly.

Prices in the RSA are the major reference for determining prices in Botswana, Lesotho, Namibia, and Swaziland, all members of the South African Customs Union. Prices in Botswana are based on those in the RSA plus a markup for transport and other costs. One purpose of this policy is to encourage the sale of the entire crop surplus to Botswana's marketing board rather than to the RSA. This has been achieved. The goal of increasing production has had less success for grains than for pulses. For example, the producer price for sorghum paid by the board is probably the highest in the region and marketing coverage has been extended into subsistence production areas, yet local procurement is still negligible.

The removal of South African subsidies on grain exports to Lesotho at the end of 1976 has put upward pressure on prices. The maize price is above RSA and world market levels while the price of wheat has also risen but remains below RSA levels. Most grain is sold to private local traders at lower but often more stable prices. Farmers lack confidence in the official body, the Produce Marketing Corporation, which has been unable to provide a reliable market at competitive prices. Given the heavy migration and associated labor shortages in Lesotho, there are already limits to the effectiveness of price policy as a means of increasing production.

The official producer price for paddy in Madagascar has been raised significantly since 1972, although it is still well below the world price. This has failed to induce production increases because of other important factors such as late payments, shortages of fertilizer, and inadequate extension services.

Input Subsidies--The use of modern inputs in Southern Africa is mainly restricted to cash crops and the more developed commercial food sectors. Several countries, including Zambia, Malawi, Swaziland, and Madagascar, have subsidized fertilizer. However, poor distribution and other problems often limit the effectiveness of the subsidies. Zambia recently cut fertilizer subsidies. In addition to the high costs to the government, it was felt that large subsidies had led to considerable waste.

Subsidized inputs, such as fertilizer and improved seeds, or special credit funds for their purchase, are generally provided in rural development and package programs. Botswana, Lesotho, Zambia, and Malawi currently operate programs of this nature. To assist resettled refugees, Zimbabwe is distributing free "crop packs." These packs contain inputs for 0.5 ha. and some implements such as hoes and ox-drawn ploughs.

Until 1980, labor had been indirectly subsidized in Zimbabwe to benefit commercial farmers. There was no minimum wage and foreign workers were allowed to work on farms despite high unemployment within the country. This situation is now changing and will affect operations on these farms as labor becomes more expensive.

Credit--Credit systems reflect the dualism in Southern African agriculture. Large commercial farmers have access to credit through private commercial banks and specialized institutions in most countries. Smallholders have few, if any, sources of credit and these tend to be fragmented.

Zimbabwe`s system is well developed and includes a number of channels to assist commercial farmers. Various subsidies have been used to support less successful white farmers and enable them to remain operating. Existing credit

is mostly obtained in the private sector, but the government-run Agricultural Finance Corporation includes provisions to make long-term loans to farmers unable to get private loans. This might be a useful base to use in expanding the system.

There is increasing interest throughout the region in development of smallholder credit, although the most effective ways of doing this are not necessarily understood. Zambia has started the Agricultural Finance Company for this purpose and hopes to involve local institutions, such as village committees, in processing loan applications. The desire to make profits by both private and government loan institutions in Zambia has meant that small-scale producers have usually been excluded .

To deal with the credit constraint, rural development and package programs in Botswana, Lesotho, Zambia, and Malawi include some credit funds. These are generally intended for purchase of inputs such as fertilizer and seed. However, these programs are limited in range and more credit banks are being established. Lesotho is starting the Agricultural Development Bank to coordinate credit. Malawi is setting up a land bank to provide long term-loans but this will still leave a gap for many farmers needing short-term funds. Madagascar started an agricultural bank in 1977 to make loans for capital improvements. As of yet relatively few farmers have received loans. Specialized government institutions exist in Botswana, Namibia, and Swaziland, in addition to private sources, but only serve the modern sector and often focus on livestock or export crops.

Extension--Two fundamental problems facing extension systems are a lack of skilled staff and shortage of transportation. Another common issue is the

failure to reach women cultivators, who are particularly important in Southern Africa because of the great number of men away from the farms. Concentration on more accessible commercial farmers is also widespread.

Zambia is starting a smallholder delivery scheme of some promise called Lima. This involves a simple package of inputs for a small, standard-size plot along with credit, management advice, and guaranteed timely payment for the product, maize. The World Bank`s training and visit method of extension will be employed. The Lima approach is intended to eliminate inappropriate and confusing recommendations plus integrating extension with other needs.

The National Rural Development Program in Malawi aims to improve small farmer efficiency and yields in large parts of the country. The program is broad and long-range in orientation. Infrastructural development, provision of improved crop varieties, extension education, credit, inputs, and marketing are the main features. Some extension services are also provided by specialized crop agencies, such as the Small Holder Tea Authority and Small Holder Sugar Authority. Extension services in Malawi, although limited by available resources, deal with both food and cash crops.

Botswana, Lesotho, and Swaziland have severe manpower constraints, but all have some special programs with extension components in addition to rather thin extension agencies. These are the Basic Agricultural Service Program in Lesotho, Botswana`s Arable Lands Development Project, and the Rural Development Areas Program in Swaziland. The latter includes livestock management but the common focus is increasing food crop production by subsistence farmers.

The sophisticated extension system in Zimbabwe is geared for the white commercial farmers, but there is an extension agency for African farmers called DEVAG. The future direction of extension policy will depend on structural and land tenure decisions.

Research--Historically, Zimbabwe has had a very strong research program. It is difficult to predict the direction of research policies under the new Government. Zambia's research is hampered by over-reliance on expatriates, as in most of the region. The successful adaption of hybrid maize has not been matched by any other dramatic breakthroughs. Canadian assistance is being used to study wheat production. Related to the LIMA program, research on farming systems is now being stressed.

Elsewhere in Southern Africa there has been little accomplished in food crop research. Very limited research resources have largely dealt with livestock or cash crops. Malawi is attempting to develop packages for smallholder food and cash crops and most of the other countries have similar goals.

Crop Procurement--Government involvement in food crop marketing is increasing in Southern Africa. Madagascar nationalized rice marketing in 1972. Since 1974, new state or parastatal marketing boards have been created in Mozambique, Lesotho, and Botswana. Totally private marketing channels exist only in Namibia, where this trade is controlled by South Africans. In Swaziland, a private company, the Swaziland Milling Company, has a government monopoly. These organizations generally handle input delivery as well as crop procurement. The level of efficiency and degree of control over marketing differs greatly among the various marketing boards. Also, in most of the

countries, marketing networks for livestock or cash crops are more developed than for food crops and often have more private sector involvement (table 59).

Marketing constraints on production are most pronounced in Mozambique, Zambia, and Madagascar. The colonial market system in Mozambique completely

Table 59: Major marketing institutions for food crops, Southern Africa.

Country	Marketing institutions	Acronym	Food crops covered 1/
Botswana	Botswana Agricultural Marketing Board	BAMB	Wheat, sorghum, maize, pulses, 2/
Lesotho	Produce Marketing Board	PMC	Maize, wheat, sorghum, pulses 2/
Madagascar	12 Parastatal Companies		Rice
Malawi	Agricultural Development and Marketing Corporation	ADMARC	Maize, pulses, rice, 2/
Mozambique	National Directorate for Agricultural Economics and Marketing	DINECA	Maize, others-N.A.
Namibia			
Swaziland	Swaziland Milling Comany 3/	SMC	Maize
Zambia	National Agricultural Marketing Board	NAMBOARD	Maize, wheat, rice 2/
Zimbabwe	Grain Marketing Board	GMB	Maize, wheat, sorghum 2/

1/ The procurement responsibilities of marketing institutions vary among countries and actual procurement of commodities may vary from official procurement responsibilities.

2/ Handles other food crops and/or cash crops.

3/ SMC is 50% private and 50% government owned. Crop procurement is through the Farmers Cooperative Union.

disintegrated with the departure of the Portuguese and abolition of most private trade. A new state organization for crop procurement and input distribution, DINECA, has not yet been able to cover much of the country nor work efficiently. The motivation behind DINECA was both ideological--part of the socialist transformation and attempt to eliminate exploitation--and practical--the need for some kind of marketing system. Mozambique's near bankruptcy, the demands of warfare, and other harsh circumstances made it a difficult time to introduce a new organization. The government is now planning to allow more private trading at the retail level which may affect the agricultural system.

To a lesser degree, unreliable supplies, low prices, and related problems are also characteristic of NAMBOARD in Zambia. This parastatal body shares the problems common to parastatals in Zambia: general inefficiency, overstaffing, and reliance on government subsidies to cover large deficits. Perhaps the most fundamental issue has been NAMBOARD's inability to charge realistic prices. This situation is improving as the government moves to relax price controls through the economy and streamline parastatals. Producer and retail prices have been increasing. A thorough government review of NAMBOARD is planned with the objective of improving efficiency.

Rice marketing in Madagascar is handled by 12 parastatal companies operating in different regions of the country. These companies procure rice through the local village councils (fokolonas). Since private traders were replaced, efficiency has declined. Not all rice is collected, payment deficiencies to farmers are common, and marketing costs are generally high.

Both Malawi and Zimbabwe have fairly efficient marketing boards. ADMARC in Malawi actually is a profit-making body and one of the Government's most

important sources of revenue. It is the largest economic enterprise in Malawi. ADMARC handles a number of food and cash crops, and has a monopoly for some of these. Even for those crops for which it is not the exclusive buyer, its prices are dominant. In some ways ADMARC's need to turn a profit is a constraint on farmers. Most of its profit, however, is derived from buying smallholder tobacco, groundnuts, and cotton at relatively low prices and selling at higher world prices, and food production is not necessarily discouraged.

The main food crops in Zimbabwe go through a single marketing channel, the Grain Marketing Board. This is one of a number of parastatal boards under the overall direction of the Agricultural Marketing Authority. Commercial producers are directly represented on these boards. Inputs are handled privately. The dependability and convenience of commercial marketing outlets, however, are not the case for most African farmers. Farmers in Tribal Trust Lands cannot easily market their crops. The Grain Marketing Board's minimum purchase requirements have excluded small producers. Until early 1979, official marketings from farmers in the TTL's were taxed 10 percent. These were some of the obstacles and inequities which undermined their incentives for increasing output, possibly imposed because of the white farmers' fear of competition. Changes in these arrangements are expected.

The newer bodies in Botswana and Lesotho have a mixed record. Despite an official monopoly, most food grains in Lesotho are still handled by private traders while the Produce Marketing Corporation (PMC) has dealt deals more with pulses and oilseeds. The Agricultural Marketing Board in Botswana has had more success. It has procured a higher volume of output each year and

helped to reduce price fluctuations. The overwhelmingly subsistence nature of food grain production in these two countries and in Swaziland limits the role of marketing organizations but presents a challenge for encouraging more participation in the market.

Transportation--A number of important issues influence transportation policy in the region. One is the political dimension, primarily concerning dependence on South Africa and former attempts to isolate pre-independent Zimbabwe. The great expense of road building is another concern. Some roads, such as in Botswana and parts of Zambia, cover long distances. Low population densities mean that these projects are not always economically justified, despite social or political benefits. In the north of Malawi and in most of Lesotho and Madagascar, mountainous terrain is an obstacle. Equally important, maintenance capacity is weak in most of the countries, further constraining development. Finally transportation networks reflect the dualism in these economies; the modern enclaves are generally well served while most agricultural areas have been neglected. This pattern is most pronounced in Namibia.

Mozambique and Zambia will greatly benefit from Zimbabwe`s independence because of the three nation`s intertwined railways. All three, as well as Namibia, Botswana, Lesotho, and Swaziland, are still dependent on RSA rails and ports. Mozambique faces the challenge of rehabilitating its existing transportation and developing a system more in line with the country`s needs. Portuguese colonial policy fragmented Mozambique rather than integrating it. The southern areas and links to the RSA and Zimbabwe were favored. Overall the country has very poor roads and a tremendous shortage of vehicles, many of

which were taken by the fleeing Portuguese. Mozambique`s rails and ports are mainly geared for transit trade.

Zambia and Mozambique are strengthening their transportation links, but this will not directly aid agricultural development very much. Diversification of its trade routes has been one of Zambia`s main priorities. The major project has been the Tazara railway to Tanzania. Progress has been made in construction of trunk roads within the country but feeder roads have lagged, representing a big constraint in many areas. Another aspect of transportation has been poor planning of marketing. Collection of crops and delivery of inputs has been expensive. Trucks often travel empty in one direction. Private truckers have received very high rates at times as an inducement to work at short notice.

Botswana and Malawi have devoted very large portions of their budgets to road building. American aid was used to build a link to the black north, the "Botzam" road to the Zambian border. This is not heavily used yet but has a great deal of political significance. The program in Botswana is oriented around main rather than feeder roads because of sparse population. Malawi is a smaller, densely settled country that has established a good transportation system. Canada has just extended Malawi`s railway to the Zambian border. Policy has been to spread development away from the more privileged southern part of the country. The good maintenance of Malawian roads is noteworthy.

The African areas of Zimbabwe have extremely poor transportation service. Construction and maintenance of roads has been concentrated in the white areas. This policy, of course, has greatly benefitted commercial agriculture. The rugged terrain of Lesotho has greatly contrained

modernization of agriculture. Much travel and transport depends on horses and mules. The government has recently experimented with rural works projects to build trails and roads.

Madagascar is devoting a large portion of its budget to transport and public works but many farmers are still beyond reach of the transportation system because of the rugged terrain. Furthermore strong import restrictions have limited the number of new vehicles and caused a shortage of spare parts.

Storage--Storage problems are common throughout the region. Most of the countries have expressed interest in increasing their capacity at a national level. The current food shortages in Southern Africa partly reflect limited storage capacity. Onfarm storage improvements are also needed. However, there seems to be less interest in dealing with the farm level.

Mozambique plans to construct rural storage sheds, district warehouses, and large strategic warehouses with Scandinavian aid. Most of its facilities are now located at the ports, not in producing areas. Lesotho has just built some storage space to serve a new grain mill. Botswana is stressing expansion of grain storage and recently opened a modern 25,000 ton facility at Pitsane. The most ambitious plans for strategic reserves are those of Malawi. It plans an 160,000-ton stockpile of maize, building a silo in Lilongwe which may be one of the biggest in Africa. This should provide insurance against a bad crop year.

The war interfered with Zimbabwe's plans to increase bulk storage. This may be considered again since grain trading could gain importance in the future. However, the country has a very strong base already. Zambia, as one of the most urbanized countries, has much storage space in the urban areas.

Modern silos serve the main commercial producing areas but overall capacity is short. The need for decentralized storage has been discussed but it is not clear whether any major efforts are planned for expansion.

Trade--The importance of food imports in the region has already been discussed along with dependence on the RSA. These are critical issues which policymakers are considering at present. Grain trading is handled by the state marketing agencies in most of the countries so there is official control over importing and exporting. Smuggling of grains in border areas is not a significant problem, although there is some illicit movement along the Zambian borders with Zaire and Tanzania.

Growing ties among the independent Southern African nations are a promising sign. The ability of Zimbabwe to export surplus food crops will be a critical variable. No public information concerning Zimbabwe's trade during the years of UN sanctions is now available, but clearly a large amount of agricultural products were exported, such as maize to Zaire, beef to Gabon, and tobacco to Europe. Wheat imports are sizeable and increasing rapidly in Zambia and Mozambique. These grains, unlike maize, have not been domestically produced in large quantities. Mozambique is heavily reliant on food aid and will probably be unable to afford more commercial imports for some time. Lesotho, also dependent on food aid, should benefit from its new grain mill. Up to now it has had to export its wheat to the RSA and then import wheat flour. Nevertheless it will remain a net importer.

Following a policy of comparative advantage would limit Botswana and Namibia to partial sufficiency in food crops. Their main agricultural exports are livestock and livestock products. Although the other states probably have

the capacity to attain self-sufficiency in their main foods, the RSA may offer cheaper sources as a convenient alternative in its quest to retain influence in the region.

P.L. 480 programs operate in all the countries except Namibia and Zimbabwe and have been most important in Lesotho, Botswana, and Zambia. Most of these have been Title II programs. Food aid from other sources has also been significant (table 60).

Table 60-Import record and policies, Southern Africa

Country	Average annual food self-sufficiency ratio, 1976-78 1/	Average annual cereals imports, 1976-78 2/	Average annual P.L. 480 food aid, 1976-78 3/	Import restrictions 4/
	Ratio	--1000 Metric Tons--		Policy
Botswana	5/ 71	5/ 39.5	5.5	NA
Lesotho	5/ 78	63.3	13.0	NA
Madagascar	87	174.6	1.3	NA
Malawi	100	40.2	0.6	NA
Mozambique	89	192.0	8.2	NA
Nambia	NA	NA	NA	NA
Swaziland	5/ 89	5/ 13.0	0.5	NA
Zambia	NA	61.8	0.3	NA
Zimbabwe	NA	6/ NA	0	NA

NA = Not available.

1/ The food self-sufficiency ratio is calculated as:

$$SSR = \frac{\text{per capita production of cereals}}{\text{per capita consumption of cereals}} \times 100.$$

The SSR for each country was calculated using data from the U.S. Department of Agriculture, Global Food Assessment, 1979, Table II-9 and the Food and Agriculture Organization, Production Yearbook, 1978.

2/ Food and Agriculture Organization, Production Year book, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

3/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources, Food for Development in Subsaharan Africa, March 1980. Statistics in this report were orginally from Food for Peace Annual Reports, Africa CP 1980 and other Food for Peace documents.

4/ Economics, Statistics and Cooperatives Service.

5/ 1976-77 average.

6/ Zimbabwe was a net exporter of grains during this period.

Table 61-- Selected indicators, Southern Africa.

Country	Population, 1977	--Urbanization-- Percentage of total population, 1977	Average annual growth rate, 1970-75	Per Capita GNP, 1977	Agriculture as percentage of GDP, 1977	Average annual growth rate, GDP, 1970-76	Average annual growth rate per capita production, 1965-79	--Transportation-- Total roads	Paved roads	Rail roads
	Millions	-- Percent --		U.S. dollars		--- Percent ---		---Kilometers---		
Botswana	0.7	2	NA	522	25	NA	NA	10,476	579	726
Lesotho	1.2	4	8.1	240	36	5.2	NA	3,916	218	1.6
Madagascar	8.1	20	4.3	240	38	-0.3	NA	27,500	4,525	884
Malawi	5.2	9	7.6	140	45	1/ 6.3	-2.04	12,674	1,870	678
Mozambique	9.7	7	6.8	150	56	-5.0	-2.77	26,477	4,322	3,436
Namibia	1.0	NA	NA	1,200	16	NA	NA	33,800	3,800	2,340
Swaziland	0.5	2	NA	470	30	NA	NA	2,805	390	292
Zambia	5.3	40	5.4	450	14	2.8	0.74	35,779	5,403	2,014
Zimbabwe	6.7	21	6.4	500	20	3.3	NA	78,428	7,995	3,434

NA = Not available.
1/ 1970-76.
Sources: See Appendix tables

Footnotes

1/ IBRD Report No. 1836a-SU,p.19. It is not clear from this source whether the production referred to is marketed production or total output.

2/ Fifth Lok Sabha, Estimates Committee, Fortieth Report, Fertilizer (New Delhi, Lok Sabha Secretariat, 1973), p. 102.

3/ FAO, State of Food and Agriculture, 1978.

4/ FAO, State of Food and Agriculture, 1978.

5/ The Sahel ecological zone actually extends through Sudan and Ethiopia.

6/ The mid-1977 estimate for Niger's per capital GNP is $160, but more recent unofficial Government estimates put the per capita GNP at over $300 due to rapid growth in the uranium sector.

7/ Comité Inter-Etats pour la Lutte Contre la Sécheresse dans le Sahel.

8/ This was also the case in Senegal until the 1978/79 agricultural season.

9/ Also referred to as private, parallel or illegal.

10/ The continuing civil disturbances have resulted in the absence of any efficient public or private marketing system. There is a government ban on cereals movement between the north and south.

11/ Cameroon is not a member of ECOWAS but for the purposes of this report is included in the West African region.

12/ OFN was phased out in 1979.

13/ Urban markets are mainly supplied through imports.

14/ The Trans-Cameroon railway for example plays a vital role for Chad.

15/ This ban was dropped in 1979 when grain supplies were abundant but reimposed in 1980 in response to a national shortage.

CHAPTER V. MODEL, PROJECTIONS, AND SCENARIOS

INTRODUCTION

The purpose of this chapter is threefold. First, we estimate the 1990 import demand and nutritional needs of the five subregions of Sub-Saharan Africa. Second, we use a set of scenarios to estimate the impact alternative policies and investments might have on the food situation over the next decade. Third, we compare our estimates with those of previous studies, and use the similarities and differences which exist to better characterize the food problems and prospects of the subregions.

A number of studies have attempted to estimate African import requirements. These include:

- FAO, State of Food and Agriculture, 1978

  Regional Food Plan for Africa

  Agriculture Toward 2000 (AT 2000)

- USDA, Alternative Futures for World Food in 1985 (The Grains, Oilseeds, Livestock GOL model)
- IFPRI, Food Needs of Developing Countries
- Hans Linneman et al., MOIRA: Model of International Relations in Agriculture

While our estimates build on the insights of earlier work, they differ in several important ways. First, our model includes price relationships in the equations used to estimate the supply and demand for foods in the five subregions. This provides a more realistic estimate of import demand, and permits a comparison of price impacts across subregions. Second, the supply equations capture some of the behavioral relationships characterizing food production in Sub-Saharan Africa at the micro-level. These relationships are by no means as precisely expressed as those used by our colleagues

to model agricultural production in the United States. Nevertheless, they do make it possible to move away from assuming arbitrary food production growth rates and instead to see what rates are likely, given farmers' response to prices, yield variability, and traditional cropping patterns. Third, the behavioral equations permit us to translate assumptions about prices and/or changes in production patterns into scenarios which can explore in a quantitative way some alternative patterns for the coming decade.

MODEL DESCRIPTION

The estimates of 1990 import demand and nutritional needs are based on an analysis of supply and demand for major food grains, pulses, and roots, tubers and plantains (RTP) in each of the five subregions. Wheat, rice, maize, and millet/sorghum are analyzed separately. Pulses, including beans, peas and lentils, are grouped into a single category. Cassava, yams, cocoyams, sweet potatoes, white potatoes, bananas and plantains are grouped into the single RTP category.

Equations

Supply

$$S^r_{kt} = A^r_{kt} \times Y^r_{kt}$$

where:

S^r_{kt} is total production of crop k in region r;

r is region (1 to 5);

k is crop;

t is time (years 1965 to 1979);

A^r_{kt} is total area harvested of crop k in region r; and

Y^r_{kt} is yield of crop k in region r.

To estimate the supply equation, yield was assumed to be exogenous and a separate equation was estimated for harvested area;

$$A^r_{kt} = f(A^r_{kt-1}, p^r_{kt-1}, R^r_{kt})$$

where:

A^r_{kt-1} is are harvested of crop k lagged one year in region r;

p^r_{kt-1} is farm price of crop k lagged one year in region r

R^r_{kt} is risk associated with yield of crop k in region r.

<u>Demand</u>

$$D^r_{kt} = f(p^r_{kt}, I^r_t)$$

where:

D^r_{kt} is total consumption of commodity k in region r;

p^r_{kt} is price for commodity k in region r; and

I^r_t is total income in region r.

Description of the Variables

The variables in the model are area harvested, price, risk, and yield on the supply side, and consumption, price and income on the demand side.

Area Harvested

This variable is the summation of all harvested area of a crop in a region. The lagged variable A^r_{kt-1} bears particular significance in our model. It represents the rigidity inherent in production of a subsistence crop, stemming from land suitability constraints for particular crops, farmer familiarity with certain types of crop production, eating habits, and other factors. In an operational sense, the value of this lagged variable is a measure of the farmer's perceived need to produce a staple crop in quantity sufficient for his own household, aggregated for a region.

Price

The price variable in the model is the weighted average of producer prices for a crop in a region. Regional commodity prices were calculated by converting all prices into U.S. dollars and weighting country prices by their relative contributions to regional total production. Thus, weighted average prices were used as representative prices for each region. Producer prices lagged one year were taken to be expected prices, which actually affect the producer decision-making process.

The prices used in this study are official prices. However, since there is evidence of black markets in most of the Sub-Saharan African countries, these official prices are expected to be different from market clearing prices. Thus, prices are assumed to be exogenously determined.

Risk

The risk variable is a measure of the farmer's risk aversion toward variations in crop yields. Uncertainty regarding yield is a very significant variable in the farmer's cropping decision. This is especially relevant for subsistence sector farmers who are consuming a major share of their crops. Crop yield uncertainty has been hypothesized to be more significant than

price in explaining area harvested, especially for crops for which minimum support prices exist. In good years when harvests are large, surplus production will be largely wasted in storage losses unless there is a ready market for that surplus. Area allocated to the surplus crop is likely to contract. Similarly, the consequence of a bad year is likely to be a decrease in the area planted of a crop which has been damaged the most. This is especially important for most food crops which are not produced on irrigated land.

The risk associated with yield expectation is represented by the square root of weighted square deviations between actual and expected yields over the preceding three-year period, as observed to the current expectation.

$$R^{r}_{kt} = \frac{\left[w^{i} (Y^{r} - Y^{er}_{kt-1})^{2} \right]^{1/2}}{Y^{er}_{kt}}$$

where Y^{r}_{kt} is the actual yield in region r in year t; Y^{er}_{kt-1} is expected yield as a three-year geometrically declining weighted average of past observed yields; and

$$Y^{er}_{kt} = w^{i} Y^{r}_{kt-1}$$

$w^{i} = 0.54362$. This value is obtained by solving:

$w^{3} + w^{2} + w = 1$

This expectation formula was first presented by Nerlove as an adoptive expectation hypothesis of geometrically declining weighted differences between actual and expected outcomes.

Yield

An attempt was made to estimate an equation to show the relationship of effective variables on yield. African time series input data are not abundant. Thus the original yield estimate was constrained to include only fertilizer utilization, the number of tractors, labor force, and a series of dummy variables representing weather (good or bad years).

In the process of data collection it was found that almost all fertilizer and tractors are used in cash crop production. Therefore, using the two variables in the equation explains only a small proportion of the variations in food crop yield.

The only available statistic representative of labor at the farm level was total rural population. However, based on the literature on the structure of the African farm, it was found that the effective size of labor force depends on the size of the family and its composition. These two factors are so important that they can determine the enterprise mix and the choice of technique. Another factor that determines the size of labor force is farm location; if the farm is exposed to a large labor market or is close to a border, then the off-farm migration can have a major impact on the level of available labor.

Thus, with the limited information about the structure of the rural population, it was not economically justified to estimate a yield equation based on rural population data.

Weather is known to be the single biggest determinant of variations in crop yields in Sub-Saharan Africa. Unfortunately, weather data, when aggregated on a regional basis such as ours, lose much of their explanatory power due to the effects of intraregional variation.

In order to reflect some of the influence of weather on crop yields, our model uses a distribution of yields for each region and crop, based on historical experience. The probabilities of getting low, average, or high yields of particular crops in particular regions are known. This gives our model more realism than it would have by using average yield alone.

Consumption

The consumption variable in the model is the sum of production and net imports. Because of the lack of data on stored food, it was assumed for purposes of our model that 3 years was the maximum storage period. Thus, a 3-year moving average was used to calculate the consumption variable.

Price

Only scattered data were available on wholesale and retail prices throughout the regions. Therefore, prices used on the demand side of the model are farm-level prices, and it was assumed that margins are constant for all crops in a region.

Income

Private consumption expenditure (PCE) was used in the estimation of the demand equation, since this variable is a more accurate measure of effective demand than gross national product (GNP). To aggregate PCE for a region, each country's private consumption expenditure was converted to U.S. dollar equivalent and summed over countries.

Data Sources and Method of Estimation

Yearly observations are the basic data used and the period under consideration is 1965 to 1979. The major sources of data are; FAO production year book, FAO trade year book FAO producer prices (time series up-dated by U.S. agricultural attaché reports), International Financial Statistics and World Bank "Economic Data Sheet."

The method of estimation of behavioral relation is ordinary least-squares and the functional form is Cobb-Douglas or power function. In general, the problem of auto correlation was encountered frequently. Whenever the null hypothesis of randomness between disturbances was rejected through the use of Durbin-Watson statistic the Cochran-Orcutt iterative procedure was applied. For each equation different specifications were used and statistically estimated. The equations presented in this study were considered to be best among the whole set of estimated equations. The criteria used for this determination were economic theory, a priori expected sign, low standard error and high multiple determination coefficient (R^2).

MODEL RESULTS

Our modeling provides several different kinds of information on the African food situation. First, the equations estimated provide insight into the behavioral dynamics which lie behind the historical production and consumption record. Second, projections of import requirements and food needs based on four different "trends" give an indication of the magnitude of the continent's import and calorie gap, as well as an indication of which regions will be more critical in shaping these gaps. Third, comparisons of production and demand across the four trend projections indicate the significance of price and income variations. Fourth, an analysis of the distribution of yields for commodities in each region indicates the production gains associated with improved yields. Finally, a collection of scenarios postulating significant changes from trend provide a vehicle for discussing the potential of alternative policies and production improvements.

Production and Consumption Dynamics

The dynamics underlying the historical production record (1965-79) are reflected in the coefficients of the equations which explain the area planted

to specific crops (Appendix Table 4).

The variable lagged producer price had a significant impact on area planted to rice, maize, millet, and sorghum in the Sahel, West, East, and Southern Africa (table 62). 1/ Overall, price responsiveness was greatest in East and Southern Africa, followed by West Africa and Sahel. In Central Africa, on the other hand, producer prices had no significant impact on the area planted to specific crops.

Much of this price responsiveness occurs at the margin, however. Acreage planted to specific crops tends to follow an historical pattern, perhaps reflecting the extent to which planting by farmers in the subsistence sector is dictated primarily by on-farm consumption needs and established cropping patterns. A comparison of lagged price and acreage elasticities makes the point. In general, lagged acreage elasticities are 2 to 4 times higher than lagged price elasticities. There are, however, four cases where price has a greater impact than past planting patterns----rice in East and West Africa, maize in Southern Africa, and sorghum in East Africa (table 63).

An attempt was made to estimate cross elasticities among different crops. However, because we have data on official prices which tend to be set as a package, the prices for different crops were highly correlated. It was therefore not possible to estimate cross elasticities accurately.

Acreage planted in all regions was affected by the risk associated with fluctuating yields. Risk was most important in Central Africa, followed by West and Southern Africa, and, at a much lower level, Sahel and East Africa. The hypothesis that the risk associated with yield uncertainty might be more significant than price was not totally supported, however. In all cases where there was responsiveness to both price and risk, price was more significant. In some instances, however, there was responsiveness to risk without price responsiveness. Here, clearly, risk was more significant (table 64).

Table 62--Lagged price elasticities by region, Sub-Saharan Africa

Regions	Wheat	Rice	Maize	Millet	Roots	Pulses	Sorghum
Sahel	NS	0.13	0.11	0.19	NA	NA	NS
West Africa	NS	0.24	0.11	N	NA	NA	NS
Central Africa	NS	N	N	N	NA	NA	NS
East Africa	N	0.42	0.10	0.09	NA	NA	0.27
Southern Africa	N	0.14	0.45	0.09	NA	NA	NS

NS = not produced significantly
N = not included, based on economic reasoning
NA = not available

Table 63--Lagged area elasticities by region, Sub-Saharan Africa

Regions	Wheat	Rice	Maize	Millet	Roots	Pulses	Sorghum
Sahel	NS	0.15	0.54	0.45	0.47	0.48	NS
West Africa	NS	0.14	0.30	0.27	0.66	0.56	NS
Central Africa	NS	0.65	0.83	0.77	0.97	1.28	NS
East Africa	0.84	0.19	0.56	0.46	0.79	0.69	-0.05
Southern Africa	0.42	0.51	0.38	0.33	0.86	0.28	

NS = not produced significantly

Table 64--Risk elasticity by region, Sub-Saharan Africa

Regions	Wheat	Rice	Maize	Millet	Roots	Pulses	Sorghum
Sahel	NS	N	N	-.02	-.01	N	NS
West Africa	NS	-.05	-.04	-.06	-.01	-.05	NS
Central Africa	NS	-.04	-.02	-.02	N	N	NS
East Africa	-.02	N	N	N	N	N	N
Southern Africa	-.07	-.03	-.07	-.01	-.01	-.03	NS

NS = not produced significantly
N = not included, based on economic reasoning

The aggregate picture, then, is of production responsive to both price and risk, but heavily shaped by local consumption needs and established cropping patterns.

The dynamics underlying consumption are captured in the equations representing demand for cereals, RTP and pulses (Appendix Table 4). Income elasticities, presented in table 11 (page 48), were estimated in this study to provide an alternative to now dated FAO estimates.2/ The income elasticities for wheat and rice are high in all regions, and are invariably higher than those for other cereals, RTP and pulses. Any significant increase in income can, therefore, be expected to lead to a much larger demand for these two commodities.

While all regions share the preference for wheat and rice, they differ in other important respects. While RTP are inferior commodities in the Sahel, Central and Southern Africa, they have positive income elasticities in East and West Africa. In both regions, they rank above millet and near maize. An interest in greater self-sufficiency in these regions, therefore, would be promoted by assuring an adequate supply of RTP, processing to make them convenient to use in urban areas, and adequate transportation to urban centers. Millet is an inferior product in Southern Africa, as are pulses in all regions except West Africa. This does not mean that efforts to increase production and productivity should cease, for they are important staples for many poorer people. However, programs to increase production in present conditions run the risk of easily generating unmarketable surpluses, and require careful evaluation of both relative crop prices and storage facilities.

Our estimated price elasticities (table 12, p. 49) show that consumers in most regions are quite sensitive to the price of wheat and rice. The clear exception is wheat in West Africa. However, it is important to remember

that prices used in the demand equations are producer prices for all commodities except wheat, where international prices were used. Futher research on demand for these commodities would benefit significantly from elasticities of demand which would provide evidence on the potential substitutability among commodities.

Import Demand and Food Needs

Other projections of African food needs for (for instance, IFPRI and FAO) use a single "trend" projection, then make assumptions about future patterns or establish normative targets and attempt to define what is necessary to achieve them. The method used in this study is somewhat different. We have analyzed four different trends--all plausible on the basis of past experience. The rationale for this approach is twofold. First, the 1970's have been years of substantial change, especially in the price of basic foodstuffs. No clear pattern has emerged; hence, it is useful to explore a range of trend-based possibilities. The same is true of the international economic environment, where rising petroleum prices feed substantially higher inflation rates than were common in the 1960's. Making a simple choice about what part of the experience constitutues the "trend" can severely bias analysis. Second, given a period of rapid change, comparing several alternative trends may be a useful way of identifying the impact of features currently operating, and clarifying the consequences of continuing along paths which may appear in the short run to be quite similar.

Our projections are made from four different definitions of trend. The first (C75) assumes that real per capita income and real producer prices remain at their 1975 level. The second (C79) makes the same assumption for 1979 real income and prices. The third (T65) takes the trend over the 1965-79 period, essentially smoothing out some of the disturbances of the 1970's.

The fourth (T74) is based on the patterns in the 1974-79 period, following the first major increase in oil prices and the onset of the food crisis of the early 1970's and assumes that the patterns established since then will continue throughout the 1980's.

The four projections imply very different per capita income patterns within and across regions. As table 65 indicates, real per capita income fill in most regions between 1975 and 1979. All conceptions of trend imply declines from 1975 real per capita income levels in the Sahel and Southern

Table 65--Real per capita income implied by trend projections

Projections	Sahel	West	Central	East	Southern
			Dollars		
C75	83.49	124.86	91.80	86.48	128.10
C79	58.54	112.13	95.68	73.34	77.74
T65	67.28	228.33	129.81	102.83	102.52
T74	55.65	247.38	124.47	103.78	66.49

Africa, and only moderate growth in East and Central Africa. Only West Africa, dominated by Nigeria, could expect relatively strong income growth over the next decade.

This pessemistic situation is consistent with the analysis presented in the most recent World Bank's World Development Report.2/ Oil importing Sub-Saharan Africa is projected to face the most serious income growth problem of any developing region over the 1980's. With policies to effectively cope with balance of payments and inflation, real growth in per capita GNP would be only 0.1 percent between 1980-85 and 1.1 percent between 1980-90. Without such policies, real per capita GNP would fall by 0.3 percent between 1980-85 and rise by only 0.1 percent between 1985-1990. In light of this assessment, it may be optimistic to assume that either 1975 or 1979 levels of per capita

income are maintained throughout the 1980's.

The four projections also imply different real producer prices, partly because of alternative policies and partly due to the impact of inflation. As table 66 shows, real 1975 rice prices are uniformly higher than those implied by other projection conditions. Real maize prices are generally higher under T65 or T74 conditions. Real millet prices are harder to characterize. Real 1975 prices are higher than the other alternatives in the Sahel. In all other regions either real 1979 prices (Central), or trend prices are higher.

Table 66 --Index (C75=100) of real producer prices implied by projections

Regions	C75			C79			T65			T74		
	rice	maize	millet	rice	maize	millet	rice	maize	millet	rice	maize	millet
Sahel	100	100	100	62	90	71	73	111	90	42	96	85
West	100	100	100	54	74	31	67	108	93	76	108	140
Central	100	100	100	95	206	161	87	107	109	81	104	88
East	100	100	100	51	64	55	80	156	102	92	127	51
Southern	100	100	100	82	90	85	69	69	67	83	132	116

The four projections imply quite different futures for Sub-Saharan Africa, as table 67 shows. Assuming that real 1975 per capita income and price levels prevailed in 1990, Sub-Saharan Africa would require about 11.5 million tons of imports--about half of them for West Africa. Yet, all regions except Southern would have per capita calorie intakes below nutritionally acceptable levels, and the equivalent of 12.4 million tons of cereals would be required to provide nutritionally adequate diets. If real 1979 conditions prevailed, import demand would fall to 10.2 million tons, but the calorie gap rises to 13.0 million tons. In both cases, the magnitude of food regional to eliminate current food needs is larger than the commercial import gap.

Table 67--Projected import and calorie gaps by region

Projection	Region					Total	
	Sahel	West	Central	East	Southern	Gross 1/	Net
	Thousand metric tons cereal equivalent						
C75:							
Import gap	1,220.0	5,279.4	(549.8)	2,057.6	3,434.4	11,490.0	10,921.9
Calorie gap	1,060.0	1,236.7	909.6	9,160.1	(5,845.0)	12,367.1	
C79:							
Import gap	984.6	6,558.1	(424.0)	2,141.5	727.9	10,231.8	9,489.8
Calorie gap	1,728.6	233.0	717.1	10,323.8	(2,286.7)	13,002.4	
T65:							
Import gap	964.3	11,863.9	(349.6)	2,457.7	3,294.6	18,537.6	17,128.4
Calorie gap	1,472.9	(7,131.4)	570.4	7,024.8	(5,410.5)	9,067.4	
T74:							
Import gap	1,133.0	18,167.9	(356.5)	2,543.6	(405.5)	21,082.5	19,995.6
Calorie gap	1,386.3	(14,640.8)	596.7	8,099.4	(1,215.2)	10,082.4	

1/ Sums all deficits, assuming that surpluses are not traded across regions, and that dietary improvement occurs in regions where it is possible.

Parentheses indicate surplus.

There would be significant improvement in nutrition in West Africa under either T65 or T74 conditions. This improvement would come primarily through imports, made possible by rising income. If 1965-79 trends prevailed, the 1990 import gap would be almost twice what it could be under real 1975 conditions. Of the 17.5 million tons imported, some 11.8 could go to West Africa. If 1974-79 trends prevailed, the import demand would rise to 20.7 million tons--18.2 million from West Africa.

Because the rapid increase in import demand projected in T65 and T74 comes primarily from income growth in one region, the calorie gap does not drop significantly. Even with imports of over 20 million tons a year, the annual calorie gap exceeds 15 million tons. Most of the gap is in Eastern Africa, which is projected to contain about 1/3 of Sub-Saharan Africa's total population by 1990.

Comparing the four projections provides some insight into the dynamics which operate in each subregion. In the Sahel, both production and demand decline from real 1975 levels. The import gap falls, and the calorie gap rises, which real capita income in lowest in T74, however, the import gap is higher than in C79 or T65. The reason is that real price of rice falls more dramatically than income, expanding demand and contracting supply. With real producer prices estimated to be 42 percent of C75 levels, demand for rice is 148,000 tons higher than in C75, while supply is 69,000 tons lower. (See Appendix Table

Another aspect of price relationships in the Sahel requires comment. Real producer prices for millet are below real 1975 levels in all projections, but they are relatively higher than real rice prices. Yet, the income elasticity of millet is low, and consumers are not very responsive to its price. All projection results, therefore, indicate a surplus of millet. (Appendix Table 8) If consumers did not substitute millet for wheat

and/or rice, import requirements would be between 670,000 (C79) and 850,000 (C75) tons higher.

Declining real prices also offset income declines in West Africa. Real per capita income in C79 is lower than in C75. Yet, demand is higher, for the real producer price of rice, maize and millet fall more significantly than real income. Supply is lower than in C75, and the import gap is therefore larger.

In both other projections, real income growth makes demand much higher in C75. Yet, total production is lower. The reason is that the real producer price for rice is significantly lower, and rice production drop relative to C75 levels.

Our study, unlike FAO's earlier work, found a positive income elasticity for RTP in West Africa. Our projections indicate that by 1990, demand for RTP will outstrip production. Meeting this demand with cereals instead of RTP would require the equivalent of between 869,000 (C79) and 1.5 million (T74) tons of wheat. An interest in greater self-sufficiency would suggest focusing more attention on the production and processing of these staple foods.

Because production was not price responsive in Central Africa, differences among projections reflect only income changes and consumer price responsiveness. While the subregion shows a no overall import gap, this is slightly misleading. A large "surplus" of RTP more than offsets cereal import requirements on paper. However, the same lack of infrastructure which limits farmer price responsiveness also makes it impossible to move these foodstuffs to major cities where cereals are demanded. In addition, the negative price elasticity for RTP suggests that consumers would be unwilling to substitute them for more preferred cereals. Without the offsetting RTP production, Central Africa faces

a 1990 cereal import deficit of between 926,000 (C75) and 1.5 million (T65) tons. (Appendix Table 10)

East Africa experiences relatively little fluctuation in total demand--due primarily to the low level of growth in real per capita income. Three features of this demand, and its relation to the inport gap, are worth noting. First, if constant 1975 income and prices prevail, by 1990 there will be a significant "surplus" of millet and sorghum--almost 820,000 tons. If this grain does not substitute for more preferred wheat, rice and maize, the cereal import gap could be substantially higher. The imbalance is even greater in T65 and T74, where millet and sorghum prices are relatively higher. Given the low income elasticity of millet (0.01) and the low level of price responsiveness, substitution seems problematic at best. Second, the maize import requirements in T65 and T74 are substantially higher than in C75, despite substantially higher real producer prices. The reason is that consumers are not significantly price responsive. Hence, given a reasonably high income elasticity (0.28) demand continues to rise, even in the face of higher prices. Since maize is the staple crop throughout much of the region, the deficit becomes substantial (556,000 tons in T65, 704,000 in T74). Finally, our study estimates a rather high, positive income elasticity (0.27) for RTP. Since RTP are second only to maize as staples, the effect is significant. By 1990, demand exceeds supply by the equivalent of between 1.2 million (T74) tons of wheat. (Appendix Table 10).

The results for Southern Africa must be tempered by a recognition of the historical deadline in both production and consumption discussed earlier. The abnormally high income elasticity of demand for wheat undoubtly reflects this, as does the more than inadequate *per capita* calorie intake. More detailed analysis of diets at different income levels is necessary to correct the

picture. Unfortunately, it is beyond the scope of the present work. In addition, the projections are heavily affected by the description resulting from warfare in the area. Extrapolating these patterns into the next decade is undoubtedly too pessemistic.

The highest 1990 import gap occurs if real 1975 income and prices prevail. The lower gap for other projections reflects declining demand. The 1990 demand under T74 conditions is only 78 percent of C75 demand. On the other hand, 1990 supply under T74 conditions is 105 percent of 1990 demand for C75. The reason is that real producer prices for maize and millet increase substantially over C75 levels.

The discussion thus far suggests that changes in producer prices are consistently reflected in projected production and import gap levels. How important are these variations in aggregate? One way to answer the question is to compare the difference in production between the scenario with the lowest real producer price and that with the highest. As table 68 suggests, the difference is generally substantial. The most striking impact is in East Africa, where price-related production effects are nearly equal to the region's import gap.

Variations in yield-generally associated with weather, pests and disease-- also affect production levels. Projections based only on average yields cannot show the impact of yield variability. Using the method described in Appendix D, however, it is possible to indicate both the variation in production and the implications for import requirements of obtaining yields on the low or high end of the distribution. These results are summarized in table 69. Yield variability has an enormous impact on production levels and import gaps

or all countries in a subregion are likely to experience low yields simultaneously, nevertheless, the aggregate figures indicate graphically just how

Table 68 --Impact of price differences in alternative projections

	High price projection	Low price projection	Difference in high and low production (1,000 metric tons)	Difference as percentage of low production (%)
Sahel				
Rice	C75	T74	66.8	12.6
Maize	T65	C79	11.6	5.7
Millet/ Sorghum	T75	C79	287.9	6.4
Total			366.3	
West				
Rice	C75	T74	697	31.8
Maize	T65/T74	C79	159.3	5.1
Millet	Production not price responsive			
Total			856.3	
East				
Rice	C75	C79	121.0	31.8
Maize	T65	C79	570.3	9.1
Millet	T65	C79	108.3	5.4
Sorghum	T74	C79	427.0	9.5
Total			1,226.5	
Southern				
Rice	C75	T65	83	3.1
Maize	T74	T65	674	10.7
Millet/ Sorghum	T79	T65	33.1	5.1
Total			790.1	
TOTAL			3,239.2	

Table 69--Projected import gaps under low, average, and high yields

Projection	Region					Total	
	Sahel	West	Central	East	Southern	Gross 1/	Net
	Thousand metric tons cereal equivalent						
C75:							
Low	2,348.5	13,431.3	850.1	4,690.9	5,974.8	27,295.6	27,295.6
Medium	1,220.0	5,279.4	(549.8)	1,537.9	3,434.4	10,921.9	11,471.7
High	202.3	354.6	(2,283.7)	(2,169.8)	(1,320.1)	566.9	(5,216.7)
C79:							
Low	2,065.1	10,632.1	975.9	4,526.8	3,272.1	21,472.2	21,472.2
Medium	984.6	6,558.1	(424.0)	1,643.2	727.9	9,489.8	9,913.8
High	22.0	1,783.0	(2,157.9)	(2,116.9)	(4,026.6)	1,805.0	(6,496.4)
T65:							
Low	2,081.5	15,882.3	1,050.3	4,385.3	5,808.5	29.207.9	29,207.9
Medium	964.3	11,863.9	(349.6)	1,355.2	3,294.6	17,128.4	17,478.0
High	(31.4)	6,966.0	(2,083.5)	(2,576.5)	(1,404.4)	6,966.0	870.2
T74							
Low	2,258.0	22,203.2	1,043.4	4,455.2	1,885.5	31,845.3	31,845.3
Medium	1,159.7	18,167.9	(356.5)	1,430.0	(405.5)	19,995.6	20,757.6
High	97.3	13,386.7	(2,090.4)	(2,504.7)	(5,229.1)	13,484.0	3,659.8

1/ Sums all deficits, assuming that surpluses are not traded across regions, and that dietary improvement occurs in regions where it is possible.

Parentheses indicate surplus.

sensitive African production is to the natural environment—primarily weather. Uniformly poor yields could double the import gap for many regions. High (but historically achieved) yields could eliminate the gap in East and Southern Africa, and substantially reduce it in the Sahel.

Several important points flow from these results. First, because yield variability so overwhelms the effect of price policy, attempts to use price as a policy instrument must be well coordinated with storage and marketing policy. If it is not, unanticipated shortfalls or bumper crops will frustrate policy aims. Particular attention must be paid to dealing with better than anticipated crops, since they can pose difficult storage, transport and financing problems. Second, substantial gains in production could be achieved if yield variation were reduced, and yields stabilized toward the high end of historical distribution. This theme will be explored in some of the scenarios which follow.

The projections indicate what to expect if there are not significant changes in food demand and supply dynamics. We wish to move beyond this, however, and ask about the implications of making significant interventions to change diets, stimulate greater production, and alter prices to achieve a range of goals, including greater food self-sufficiency. The vehicle for exploring the possible impact of these changes in the scenario. A scenario is created by first defining a change in some aspect of food production, marketing or consumption. The postulated change becomes the basis for a new run of the model, which in turn shows consequences of the change. ?

SCENARIOS

Our model was used to generate eight scenarios incorporating likely or possible developments in the food supply and demand situation in Sub-Saharan Africa in the coming decade.

Scenario 1

This scenario postulates an increase in production of rice in West Africa initiated by government investments in improvements in infrastructure, including irrigation infrastructure, resulting in an increase of 5,000 ha. annually over a period of 10 years in cropped area. The scenario assumes that one-half of this increase in the improved area will be planted in rice and one-half in non-food cash crops.

In West Africa, several types of rice production discussed in this report occur. Moormann and Veldkamp have pointed to the 1,000-mm isohyet as being the demarcation line between marginal and sub-marginal rice production in West Africa.3/ All of our West Africa region lies within the 1,000-mm isohyet, except for relatively minor portions of northern Ghana and Benin. Thus, it is clear that rice production is well adapted to the region. Comparative data, including economic data, on various rice production methods in Sierra Leone have been collected by Spencer and Byerlee, and some of these data are reproduced in table 70.

Table 70--Costs and returns of rice production methods, Sierra Leone

	Upland	Lowland	
		Traditional swamp	Improved swamp
Labor input (hrs./yr./acre)	953	736	1,393
Yield (lbs./acre)	798	1,260	1,734
Output per man-hour)	.837	1.712	1.245
Value of output (Leones/acre) 1/	67	105	144
Total variable costs (Leones/acre)	11.8	9.1	33.4
Gross margin (Leones/hr.) 2/	.06	.13	.08
Profit per unit output (Leones/lb.) 3/	.069	.076	.064
Variable costs per unit output (Leones/lb.) 4/	.0148	.007	.0193

1/ 1 Leone = US$1.00.
2/ Gross margin is value of output minus total variable costs divided by labor input. Gross margin represents return to family labor.
3/ Profit per unit output is value of output minus total variable costs divided by yield.
4/ Variable costs per unit output is total variable costs divided by yield.

Source: Data from farm management survey conducted in Moa region in 1974-75 and reported in Dunstan S. C. Spencer and Derek Byerlee, "Technical Change, Labor Use and Small Farmer Development: Evidence from Sierra Leone." Paper presented at the annual meeting of the American Agricultural Economics Association, Pennsylvania State University, University Park, Pa., August 1976.

Strictly upland rice production (Type 11 in table 24) takes place on well-drained land not subject to flooding where rain is the only source of water. This type of production fits into the rotational bush fallow system of cultivation. The forest vegetation is cut, allowed to dry, and burned between January and April. These operations account for the relatively high labor input in this method.

With the onset of the rains, the land is slightly plowed, seeded by broadcasting, and harrowed with a short-handled hoe. Traditional rice varieties are planted and intercropped with cassava, maize, and broad beans in many cases. Hand weeding is necessary. Hand harvesting with a small knife usually takes place between August and October. Yields are held low by unfavorable rainfall distribution and poor soils. Rainless periods often occur and are damaging to the crop, even in areas of annual rainfall of 2,000-mm or more.

Rice is also grown in lowlands in Sierra Leone in inland swamps (Type 221). Here, water runoff is retained in swampy areas and provides moisture for the plants, resulting in higher average yields than for upland rice. Such swamps are traditionally cultivated for a number of years before being fallowed. The swamps are not completely destumped, and all operations are done by hand. Transplanting is usual, but broadcasting seed is not uncommon. Only one crop is planted each year in pure stands.

Improved swamp cultivation, involving partial water control (Type 222), has been practiced in Sierra Leone on a pilot basis since 1966-67. This method involves destumping, partial land levelling, and the construction of dikes and contour bunds. Use of improved rice varieties and fertilizer is feasible in this method. Yields have been nearly doubled over yields obtained in unimproved (without water control) swamp cultivation.

The transition from no water control to partial water control in lowland rice production in West Africa represents a step up in terms of productivity. There exists potential for expanding the area of lowland rice production with partial water control in West Africa. Spencer and Byerlee estimate that at present only about 65,000 ha. out of 300,000 ha. suitable for inland swamp cultivation in Sierra Leone alone are being cultivated. Much of this could be moved into improved swamp cultivation, of which the existing area in Sierra Leone is said to be only 8,500 ha.

Moormann and Veldkamp point out, however, that while the total area of potential rice production in West Africa is great, the poor quality of soils significantly reduces that potential. The largest soil areas of the region comprise orthic ferralsols, xanthic ferralsols, and ferric luvisols. The chief limitation of the first is their low content of fertilizing elements. The fairly low natural fertility of the second depends on their clay content. Ferric luvisols are generally severely weathered and are thus characterized by a clay fraction with a low exchange capacity.

The better soils are found in the lowlands. They are less strongly leached and have a better clay content, implying a higher cation retention. In the lowland areas, superior hydrological conditions of the often override soil-imposed restraints. Thus, for instance, while sandy soils are almost always unsuited for upland rice cultivation, this is no longer so when such soils are found in swamp areas. They still have a distinctly lower production potential than more finely textured soils in the same areas, but rice cultivation with reasonable assured returns is possible.

Thus, it seems logical to conclude that additional areas can be brought under rice cultivatin with improvements in large areas of West Africa.

In addition to this potential, there is also potential in West Africa for irrigated production from major government-financed impoundment projects on major rivers: examples are the Kpong irrigation project in Ghana and the Kainji Reservoir in Nigeria.

In this scenario, it is assumed that one-half the 2,500 ha. of additional land brought under improved rice production annually stems from improving swamplands and the other hanf from irrigation projects.

An important assumption affecting both types of rice production is that there will be sufficient labor to produce the crop at the level of productivity indicated.

Variable costs per unit output under the improved swamp method are more than double those in the unimproved method. This proportional increase

is applied to producer prices on a one-time basis. A weighted average of costs of production is used to calculate the producer price in the model run.

The model results, given in table 71, reflect changes in acreage, yields, yield risk, and price, all operating simultaneously. To obtain these results, synthetic price, risk, and yield values were calculated, and these were then substituted in the area equation in order to obtain area, and hence, total rice production in West Africa. T65 trend prices were used.

The implication of the scenario is that government improvements in infrastructure, including irrigation infrastructure, providing for an increase of 2,500 ha. per year in total rice area will yield a 17.5 percent increase in annual production of rice in the region by 1990 over and above the projected production without such investment. An investment of this magnitude should be within the range of feasibility for a region that includes a number of major foreign exchange earners, notably Nigeria, Ivory Coast, Ghana, and Liberia.

Table 71--Rice production, West Africa, 1990, Scenario 1

	Without scenario	With scenario	Percent change without/with scenario
Metric tons ('000)	2,674.6	3,142.9	+17.5

Scenario 2

The Southern Africa region has great potential for increasing rice production under certain favorable conditions. Two countries of the region, in particular, could expand irrigated rice production. Madagascar already possesses a large irrigation base dating back many years. This is mainly in the form of smallholdings where irrigation dikes and channels have been constructed by family labor cultivating rice for hom consumption. Varieties grown vary by location and altitude, since the island has several different ecological zones. Mozambique, on the other hand, has two large-scale irrigation schemes lying along major river valleys. Assuming varieties well adapted to these schemes can be identified, rice will be an important constituent of the crop production pattern, in which some form of state participation (state farms, cooperatives) can be expected.

Rice yields in Madagascar have been declining since about 1973, after increasing at an estimated 2 percent annual rate between 1963 and 1970. Sharp drops in average yields were noted in 1978 and 1979. These were officially attributed to drought, although they imply some measure of deterioration in the state of irrigation works over the years, probably the result of poor maintenance. Partly as a result, the government has experienced difficulty in procurement from producers. Marketed surplus fell from 16-17 percent of total rice production in the early 1970's to 12-13 percent in 1976-77.

It seems clear that cultivation of presently existing traditional and improved varieties of rice in Madagascar could be made considerably more productive by a concerted effort to repair and upgrade small irrigation facilities, and to expand the use of fertilizers, with no change in crop technology. Two or even three crops per year could be cultivated in Madagascar and Mozambique on irrigated land. The soils of Madagascar have carried rice crops successfully for generations, and in Mozambique the soils to be placed in production are the more fertile alluvial soils. Both countries have population growth rates approximating 2.5 percent annually and a relatively low degree of urbanization. Moreover, the irrigation schemes in Mozambique involve resettlement on newly opened lands. With adequate water input, fertilizer application rates can be increased. Crop response rates have been proven to be high with good agronomic practices. Moreover, variability of rice yields would be considerably diminished by a greater degree of water control.

The farmer's attention to his cultivating practices depends in part on the price he receives for his produt. Table 72 gives data on the procurement price of rice in recent years in Madagascar.

To achieve a significant increase in rice production, procurement prices are not by themselves sufficient incentive, since such an increase is predicated on additional use by the farmer of purchased inputs, notably fertilizer and possibly pesticides as well. In Madagascar, the present urea-rice price ratio of about 3:1 is significantly higher than the corresponding ratio of international prices.

Table 72--Producer prices, rice, Madagascar

Year	FMG/kg
1966	12.6
1967	13.0
1968	13.4
1969	13.6
1970	14.2
1971	15.0
1972	15.0
1973	15.0
1974	25.0
1975	30.0
1976	30.0
1977	35.0
1978	35.0
1979	38.0

The governments of Madagascar and Mozambique have strong incentives to increase rice production. Madagascar has had to import rice in progressively larger quantities in recent years to make up the deficit in domestic production. The current c.i.f. price of imported rice ranges between 90 and 95 FMG/kg., which is above the equivalent cost of domestically produced rice at retail (about 75 FMG/kg. at a procurement price of 35 FMG/kg.). The subsidy paid by the government in order to sell rice at retail at the uniform fixed price of 55 FMG/kg. is thus larger in the case of imported rice than in that of domestically produced rice.

Mozambique had to import 340,000 tons of rice, maize and wheat in 1978 and continues to import to make up for a deficit in domestic production.

In order to lower the cost of fertilizer from its present high level of c.i.f. import prices, the government of Madagascar has reportedly decided to construct a fertilizer plant at Toamasina. Neither Madagascar nor Mozambique has any major fertilizer manufacturing capacity at present.

This scenario assumes that the new fertilizer factory in Madagascar will come on stream in the year 1980, and this will enable the government to effect a significant reduction in the fertilizer-rice price ratio, other things being equal. The new price ratio will be an incentive to farmers to increase their level of productivity without any change in the level of technology.

Since the model, on the basis of analysis of data from the recent past, postulates a significant positive relationship between producer price

and production in the Southern Africa region, the expectation is that the change outlined above will result in a significant increase in irrigated rice production in the region. In the model, producer price acts on production through area planted; since irrigation permits multiple cropping, the effect of a price incentive in irrigated agriculture is to expand the area cropped per year (gross cropped area), just as if new land were being cleared and brought into production.

We will postulate, on the basis of the resources discussed above, that the area under irrigation in 1980 doubles by 1990 in the case of Madagascar and quadruples in the case of Mozambique (table 73).

The average rice yield in Madagascar in 1979 was 1,838 kg./ha. This average represents yields of both irrigated and rainfed rice production. Thus, we will take as our indicative starting yield for irrigated rice the figure of 2,900 kg./ha. cited by Arraudeau as representing yields in farmers' fields with local varieties recorded by IRAT in the period 1962-75. The average yield of local varieties in experimental plots was 4,400 kg./ha., representing the potential difference stemming from improved cultivating practices. We will take this as the average yield in 1990 in the model run.4/

T65 trend prices are used in this scenario to calculate the impact of increased rice production in Madagascar and Mozambique on the food situation of the Southern Africa region.

Table 73--Data input to model run, Scenario 2

Year and country	Total area of rice production	Of which irrigation
1980		
Madagascar	1,077	400
Mozambique	70	35
1990		
Madagascar	1,477	800
Mozambique	175	140

Table 74--Rice production, Southern Africa, 1990, Scenario 2

	Without scenario	With scenario	Percent change without/with scenario
Metric tons ('000)	2,677.3	5,119.6	91.2

The implication of the scenario is that a combination of government investments in irrigation and accompanying enactment of policies affecting producers' incentives in two countries of Southern Africa can nearly double production of this staple grain by 1990.

Scenario 3

This scenario tests the effectiveness of the risk factor in influencing production decisions by food producers in several of our subregions. It is hypothesized that producers regard the risk associated with crop yield variability as a serious disincentive to production, and therefore that reducing that risk, through introduction of new crop technology in the form of crop varieties better able to maintain performance in the face of weather variability, especially, will induce farmers to plant more area to such crops.

If this hypothesis is correct, the greater crop acreage devoted to crops where new technology of this kind has been introduced will manifest itself in greater production, and therefore this scenario compares the self-sufficiency ratios in particular crops of importance of food balance with and without such technology.

The results of this scenario show an increase in the self-sufficiency ratios in all cases. This increase stems entirely from a reduction in the risk factor through reducing the variability of yield, a factor bearing on farmers' expectations.

The implication of this scenario is that new crop technology, even if it does not result in higher average yield, but merely reduces the yield variability (through incorporation of drought resistance and other characteristics into crop varieties), will have a significant impact on food crop production in Sub-Saharan Africa.

Table 75--Self-sufficiency ratios, 1990, Scenario 3

Projections	Subregions	Crop	Percent reduction in yield variability	Self-sufficiency ratios: Without scenarios	Self-sufficiency ratios: With scenarios
Constant '75	West Africa	Maize	30	1.025	1.389
Constant '79				.9754	1.005
Trend				.9475	.997
Trend '74				.91364	.937
Constant '75	West Africa	Millet	30	.9701	.9908
Constant '79				.9795	1.001
Trend				.919	.939
Trend '74				.912	.932
Constant '75	Central Africa	Rice	30	.5436	.572
Constant '79				.5106	.5377
Trend				.57356	.604
Trend '74				.5253	.553
Constant '75	Southern Africa	Maize	50	1.018	1.51
Constant '79				1.193	1.43
Trend				1.032	1.27
Trend '74				1.3934	1.809

Scenario 4

The volume of cereal imports into West Africa has risen dramatically in the past 15 years. Wheat, which is hardly grown in the region at all, constitutes a major share of these imports. Although rice is widely grown in West Africa, the region shows a sizeable net deficit in this crop. Finally, some maize is also imported to fill a small deficit in this crop (table 76).

It will be seen that Nigeria, Ivory Coast, and Ghana are the region's biggest cereals importers, accounting for roughly 85 percent of total imports. Other major cereals importers are Cameroon, Guinea, and Benin.

One policy option open to governments in West Africa is to restrict imports of cereals not produced domestically and to educate their people to the consumption of substitute grains or other products. In this manner, governments can reduce the high cost to themselves of cereal imports while still meeting urban demand.

This scenario is based on the premise that an imports-restriction policy is adopted by the governments of the region's three major importing countries. Adoption of such a policy by these three would obviously have a major impact on the food supply/demand situation of the region as a whole. The object of the scenario is to look at the consequences, and particularly the costs to the governments, of adopting such a policy.

With imports restricted, the governments concerned will be compelled to find an alternative source of cereals to meet their commitments to feed

Table 76--Cereal imports, West Africa, 1978

Country	Imports		
	Wheat 1/	Rice	Maize
	Thousand metric tons		
Benin	63.6	22.0	0
Cameroon	103.1	18.8	0
Ghana	177.9	25.0	45.0
Guinea	30.6	54.0	8.2
Guinea-Bissau	9.0	36.7	6.0
Ivory Coast	183.3	123.0	20.0
Liberia	16.5	47.9	1.0
Nigeria	1,109.2	761.0	97.0
Sierra Leone	20.9	18.2	0
Togo	15.0	18.5	2.0
Total	1,729.1	1,125.1	179.2

1/ Including wheat flour (grain equivalent).

Source: FAO, Trade Yearbook, 1978.

their urban massas. This source must be domestic production. At present however, rice production in West Africa lags far behind rice demand, and wheat is hardly produced in the region at all.

Maize is a possible alternative cereal. Maize is grown widely in the region, and is often treated by farmers like a cash crop. Educating urban consumers to greater consumption of maize will, however, be a major undertaking. This scenario assumes that the Governments of Nigeria, Ivory Coast, and Ghana will find it necessary to undertake a campaign to replace consumption of wheat and rice with consumption of maize.

Our model run calculates the production increase required by the above scenario, and the acreage planted to maize that this increase implies. The price elasticity of maize on the production side of our model is positive and significant, but small. Therefore, we can hypothesize that a large price increase will be necessary to bring forth the production increase required. This, too, represents a cost burden to governments.

Using projected 1990 world prices for wheat and rice, the total amount of foreign exchange saved by the three governments concerned due to restricting imports of these cereals is then compared to the total cost of the price subsidy to producers.

Table 80 shows the calculation of the area of maize production needed, and the annual growth rate of area implied to attain self-sufficiency of cereals by 1990, assuming that maize is substitutable for wheat and rice on a one-for-one basis.

Table 77--Maize production area needed, 1990, Scenario 4

Projection	Cereal gap				Area required 1/	Annual growth rate
	Rice	Maize	Wheat	Total		
	Thousand metric tons				1,000 ha.	Percentage
Constant '75	454.9	132.4	3,749.9	4,072.4	3,842.8	1.5
Constant '79	1,785.9	2/ 79	3,741.3	5,606.2	5,267.4	3.82
Trend	3,107.5	182.6	6,793.5	10,083.6	15,232.9	9.1
Trend '74	7,554.9	306.6	8,352.4	16,213.9		14.0

1/ Using maize yield of 1.0655 MT/ha., which was the maximum yield in our data for the period 1965-79. Additionally, the risk factor has been reduced 25 percent to account for technological change.

2/ Parentheses indicate surplus.

Fitting these values of area into our supply equation, we can then solve for producer price required to elicit this response. The results are given in table 78.

The large, even unrealistic, magnitude of the producer prices required to elicit the calculated required production increase can be seen from Table 78. The main explanation for the high values in Table 78 lies with the small price coefficient in our supply equation, which has a value of 0.11 for maize in West Africa. By contrast, the similar coefficient for rice is 0.24.

The assumption of all other things remaining equal means that in our model runs the 0.11 value of the price coefficient (elasticity of price response) is preserved throughout the run. In reality, however, the value of this coefficient would probably increase through time as farmers came to perceive maize as an important cash crop for which there was great demand, and as they gained confidence in the government's ability and reliability in paying them incentive prices to produce it. Put another way, governments would have a strong interest in raising the value of this coefficient in order to reduce their own subsidization costs.

In order to show the sensitivity of maize production to a change in the price-response coefficient in our model, we have arbitrarily increased the value of this coefficient by 10 percent. The results of this change on the producer price needed to stimulate the added production of maize and the consequent saving to governments in the form of reduced subsidy of producer prices required, as shown in table 79.

Table 78--Producer maize price needed, 1990
Scenario 4

Projection	Producer price needed
	US$/MT
Constant '75	1,961.3
Constant '79	18,817.0
Trend	522,271
	12,011,737

Table 79--Effect of 10 percent increase in price coefficient

Projection	Producer price needed	Percentage saving
	US$/MT	
Constant '75	1,042	47
Constant '74	8,285	66
Trend	174,343	76
Trend '74	3,087,725	74

Scenario 5

Rice is a long-standing staple food in Senegal accounting for one-fourth of all grain consumed in the country. It is an important item in both urban and rural diets. In urban areas, per capita consumption greatly outpaces the consumption of any other cereal.

The bulk of domestically produced rice has historically been consumed in the regions of production. High domestic costs of production, plus high transport costs, and urban consumer preferences for imported Asian rice have inhibited the effective marketing of domestically produced rice in urban areas. As a result, only 24 percent of total rice demand is satisfied by local production, and rice imports therefore account for a substantial portion of Senegal's foreign exchange outflow.

As has been stated above, the Government of Senegal has an announced intention of achieving food self-sufficiency. With this aim in view, current plans are to eliminate 50 percent of rice imports in the medium term and 100 percent of rice imports in the longer term, without any specific target date (see above, p. 185).

Senegal's Food Investment Strategy (FIS) calls for a 208 percent increase in domestic paddy production over 1975 levels, and a commensurate drop in rice imports by 77 perent to 48,000 tons by 1985.

On the demand side, the FIS foresees a substantial reduction in per capita rice consumption in favor of increased consumption of millet and maize. Efforts are being made to reduce imports and to stimulate consumption of

local cereals by means of advertizing campaigns. Bakers are required to use a certain percentage of millet flour in bread and an instant couscous is being experimented with.

In this scenario, the impact of a policy of restricting rice imports on total rice demand in the Sahel and on the rice self-sufficiency ratio for the Sahel subregion as a whole will be examined. (Although many of the same trends of rice consumption can be observed in the other countries of the subregion, the scenario will limit itself to examining the impact on the subregion of an import-substitution policy in Senegal alone.) In addition, assuming complete substitutability between maize and millet on the one hand and rice on the other, the scenario will examine the impact of surpluses of production domestically of the former cereals on the gap between rice demand and supply in 1990.

It is assumed in this scenario that per capita consumption of rice in Senegal decreases by 30 percent between 1975 and 1990 due to the effects of advertizing campaigns in favor of domestically produced cereals, and import restrictions on rice.

It is further assumed that the ratio of rice consumption in Senegal in 1990 is the same as in 1979, which is about 42 percent. A decrease in rice consumption by one-third in Senegal causes a decrease in total rice consumption in the subregion of 14 percent.

Finally, in this scenario while maize area in Senegal triples, millet area follows the base trend, and prices of all cereals follow base trends.

The results of the scenario in terms of self-sufficiency ratio for the Sahel subregion are shown in table 80.

It is recalled that these results show the effects of an import-substitution policy in Senegal alone on the food supply and demand situation in the Sahel as a whole. Because millet is a crop that is produced in far larger quantity in the Sahel than either rice or maize, millet production (which is, on the whole, in equilibrium for the region) masks the full effect of the rice import-substitution policy. Thus, the results have also been calculated for rice and maize separately from millet.

Table 80--Self-sufficiency ratios, Sahel, 1990,
Scenario 5

Projection	3-crop average 1/			2-crop average 2/		
	Without scenario	With scenario	Percentage difference	Without scenario	With scenario	Percentage difference
Constant '75	.89	.91	2.2	.35	.41	17.1
Constant '79	.91	.93	2.2	.39	.44	12.8
Trend	.91	.93	2.2	.37	.43	16.2
Trend '74	.89	.91	2.2	.35	.40	14.3

1/ Rice, millet, and maize.
2/ Rice and maize.

Scenario 6

An intersting result of the estimation of the parameters of the supply equation in our model was that none of the coefficients for the price variable on the right-hand side of the equation was significant for the crops for which we had data in Central Africa.

We hypothesize, on the basis of other knowledge about agricultural production in the region derived from many sources, that the lack of price responsiveness of farmers stems from the poor quality of the transportation infrastructure in the region, which presents a serious obstacle to marketing.

In terms of road infrastructure per unit area, the Central African countries o Zaire, Angola, Central African Republic, Gabon, and Congo rank respectively 15th, 18th, 24th, 29th, and 30th among the 40 countries listed in Appendix Table 1. This provides a general idea of the poor quality of road infrastructure, especially when it is remembered that large portions of the Sahel countries, and some countries in Southern Africa, consist of desert where there is little or no agricultural production or marketing. In some instances, the Central African countries have experienced a deterioration of their road infrastructure since independence.

Marketing links are essential for farmers to respond to price incentives in their production. In order to test the efeect on aggregate food crop production in Central Africa of price signals of this nature, significant coefficients for the price variable from other regions in our study were

substituted in the supply equations for Central Africa. For this purpose, the lowest coefficient was chosen for the three crops: rice, maize, and millet. The results are shown in table 81.

The results show dramatic increases in the self-sufficiency ratios of the regin for these three staple crops, going from a deficit to surplus production in some cases. The implication of this scenario is that creating marketing links by restoring or improving infrastructure in a region where such infrastructure is notably poor will stimulate price responsiveness on the part of producers, comparable to such responsiveness in other regions of Africa, thereby permitting incentive pricing mechanisms to operate to produce a marketable surplus.

Table 81--Effect of price responsiveness on self-sufficiency ratios, Central Africa, 1990, Scenario 6

Projection	Rice		Maize		Millet	
	Without scenario	With scenario 1/	Without scenario	With scenario 2/	Without scenario	With scenario 3/
Constant '75	.5436	1.18	1.0151	1.73	.8779	1.40
Constant '79	.5106	1.11	.9386	1.59	.8414	1.30
Trend	.57356	1.36	.8273	1.43	.80503	1.30
Trend '74	.5253	1.20	.85735	1.48	.78464	1.24

1/ Rice price elasticity (Sahel) - .13
2/ Maize price elasticity (East Afirca) = .10
3/ Millet price elasticity (Southern Africa) = .09

Scenario 7

The purpose of this scenario is to measure the impact of new, yield-increasing technology and input use on the aggregate food production and self-sufficiency ratios of the subregions of Sub-Saharan Africa.

Yield increases may come from introduction of crop or mechanical technology, from greater use by farmers of inputs like fertilizers and pesticides, or from better management, or from a combination of these elements. In this scenario, no attempt is made to identify the impact of each of these elements. Instead, it is supposed that they result in a higher yield for the crop in question.

A yield figure that is historically plausible, therefore, has been chosen for each model run. In the case of all runs, the yield figure used is the highest yield recorded in our data for that crop and region. This is then used as the expected yield in the model run to project output and self-sufficiency in 1990.

The results are given in table 82.

The results show clearly the production-increasing effect of yield-increasing technology and input use. Policies and investments that encourage the introduction of such elements in their food production sectors should be supported by African governments.

Table 82-- Self-sufficiency ratios, 1990, Scenario 7

Projection	Subregion	Crop	Yield: Without scenario	Yield: With scenario	Self-sufficiency ratios: Without scenario	Self-sufficiency ratios: With scenario
C-75	Sahel	Rice	1.185	1.4958	.2895	.379
C-79					.3209	.41
T-65					.30619	.386
T-74					.27705	.350
C-75	West Africa	Rice		1.4357	.86	1.01
C-79					.58	.682
T-65					.44256	.541
T-74					.22465	.263
C-75	Central Africa	Rice	.57435	.75287	.54	.71
C-79					.51	.669
T-65					.57356	.752
T-74					.5253	.689
C-75	East Africa	Rice	1.2542	2.6127	1.1085	2.31
C-79					.7416	1.545
T-65					.85094	1.773
T-74					.9362	1.950
C-75	Southern Africa	Rice	1.8235	2.2159	.6398	.777
C-79					.8014	.973
T-65					.61697	.750
T-74					.88867	1.080
C-75	East Africa	Wheat	.91253	1.0838	.4197	.499
C-79					.4413	.524
T-65					.70015	.832
T-74					.73275	.870
C-75	Southern Africa	Wheat	1.2631	2.16	.04913	.084
C-79					.08587	.147
T-65					.054957	.094
T-74					.090459	.155

Scenario 8

One of the ways in which African governments can depress demand for cereals that are both imported and produced domestically is to pass on to consumers margins for marketing. In most of Sub-Saharan Africa, these margins are significant, and they are borne for the most part by the para-statal organizations responsible for implementing government procurement programs.

In this scenario, the demand-depressing effect of passing marketing margins on to consumers is estimated on the basis of our model of food supply and demand. The assumption of zero margins has, therefore, been dropped.

Representative marketing margins have been chosen to measure demand effects for a number of crops in several regions. For rice in the Sahel, an average of margins in Mali and Senegal has been chosen.5/ For rice in West Africa, data on margins in Sierra Leone has been used.6/ Information on margins for rice and wheat in Tanzania has been used for model runs for those crops in East Africa.7/

The results are presented in table 83.

The resulting improved self-sufficiency ratios demonstrate the demand-depressing effect of passing marketing margins on to consumers, without any other change being introduced in the production-marketing-consumption system represented by our model.

Table 83--Self-sufficiency ratios, 1990, Scenario 8

Projection	Subregion	Crop	Margin	Self-sufficiency ratio: Without scenario	Self-sufficiency ratio: With scenario
			US$		
C-75	Sahel	Rice	1.46	.2895	.396
C-79				.3209	.440
T-65				.30619	.420
T-74				.27705	.38
C-75	West Africa	Rice	1.13	.8638	1.203
C-79				.58274	.817
T-65				.46256	.646
T-74				.22465	.317
C-75	East Africa	Rice	1.38	1.1085	1.42
C-79				.74157	.954
T-65				.85094	1.09
T-74				.9362	1.20

As indicated on p. 294, there have been several studies which attempted to project African food needs. Our results are most easily compared with IFPRI and FAO's, for their geographical regions are comparable to ours. Less detailed comparisions can be move between our results, and those of USDA's GOL model and Linneman's MOIRA model, since both have features which make relatively dissaggregated analysis difficult.

In addition, we tried to compare our findings with two other studies. Wassily Leontief et al., The Future World Economy and Mihajlo Mesarovic and Edward Pestel, Mankind at the Turning Point. Their results were too aggregated to permit useful comparison, however.

The three works grouped under FAO are all outgrowths of the same research effort. The largest project is Agriculture Toward 2000--which analyzes agricultural production and demand for Africa, Asia, Latin America and the Near East. The Regional Food Plan for Africa elaborates the work on Africa done in AT 2000--disaggregating demand, supply and trade projections. The State of Food and Agriculture, 1978 contains a summary of the major features of the Regional Food Plan. The assumptions behind both the trend and normative scenarios are most completely stated in AT 2000 for definition of the assumptions and methods common to all the FAO work. More disaggregated data for Africa--necessary to remove North Africa, from AT 2000's Africa, is generally taken from the Regional Food Plan.

Projected import requirements range from a high of 28.7 million tons in 1990 to a low of 4.5 million tons in 1985 (table 84).

Table 84--Comparative import gap projections, Sub-Saharan Africa

Projection	Year 1985	Year 1990
	Million tons cereal equivalent	
U.S. Department of Agriculture:		
C74		11.5
C79		10.2
T65		18.5
T74		21.1
IFPRI:		
Constant 1975 per capita income		12.4
Low income growth		23.7
High income growth		28.7
FAO:		
Trend	11.0	12.0
Maximum production and demand (MPD)		6.4
GOL (I)	4.9	
MOIRA:		
Low income growth		11.0
High growth, greater equality		8.7

The major differences among projections have several roots. First, while most projections are based on trends, or adjusted trends, FAO's MPD is explicitly normative. It assumes strong real per capita income growth--then attempts to see what a maximum feasible effort to stimulate production could do to close the gap. Our analysis of current economic conditions indicates that both the income growth postulated for the continent, and the heavy investment necessary to stimulate rapid production through the use of imported agricultural imports are unlikely to be realized over the next decade. Similarly, the low estimate for the GOL model seems unrealistic, primarily because the present import gap exceeds that projected for 1985. The explanation for this low projection is not clear, and may lie in the structure of the model itself.

The MOIRA model has several features which make it difficult to compare with our results. Its computations are made in terms of grams of consumable protein, where our study (and all the others reviewed) deal with metric tons of cereals. A rough conversion of their results was made (110 kilograms of wheat contain about 1 kilogram of usable protein). This conversion, however, implicitly assumes that all foods have the same calorie/protein ratio as wheat. Since this is not true, our estimates of MOIRA's import and calorie gaps will be somewhat biased.

The remaining differences among projections reflect alternative assumptions about demand and production, as well as variations in country/commodity coverage. The major demand and supply assumptions are presented in Appendix tables 6 and 7. Most differences in demand reflect variations in income growth and income elasticities.

Growth rates are highest in FAO's MPD and MOIRA's high income, with high growth for Nigeria, IFPRI's low and high income growth projections. Our projections, done several years after IFPRI and FAO, contain lower and sometimes negative, growth rates--reflecting recent inflationary trends.

Differences in supply assumptions are more substantial. IFPRI assumes that production follows 1960-75 trends, while FAO adjusts this upward for its trend scenario, and assumes maximum feasible growth in production for its MPD projection. Our scenarios project the dynamics of production over the 1965-79 period, giving implied growth rates of between 1.50 and 1.67 percent.

In many cases, it was impossible to compensate for differences in country and commodity coverage. However, there was enough detail in the IFPRI and FAO studies to permit us to compute projections for regions close to our own, over commodities quite similar to ours. This involved aggregating results a bit differently for IFPRI's work, and approximating root and tuber figures for FAO's trend projection. The complete results are presented in Appendix Tables 8,9, and 10.

Removing the impact of some differences in country and commodity coverage narrows the variation among projections of aggregate import demand slightly. Our C75 estimate is quite close to IFPRI's--both in the region of 11.5 million tons--reflecting the impact of including Sudan in IFPRI's "Subsaharan" results. Including roots and tubers varies FAO's 1985 trend projection to about 11.9 million tons (cereal equivalent).

There are, however, major differences in the regional import deficits, as table 85 shows. These by in large reflect difference in the structure of supply and demand within the regions and the way such differences are handled in the projections.

Table 85—Comparative import gap projections, by region

Projection	Region: Sahel	West	Central	East & Southern
	Thousand tons cereal equivalent			
USDA:				
C75	1,222.0	5,279.4	(549.8)	5,492.0
C79	984.6	6,618.1	(424.0)	2,869.4
T65	964.3	11,863.9	(349.6)	6,058.5
T74	1,133.0	18,167.9	(365.5)	2,138.1
FAO:				
Trend	1,884.4	3,910.9	1,529.1	4,582.1
MPD	140.6	2,425.4	105.5	1,617.2
IFPRI:				
Constant 1975	3,092.0	9,236.0	(1,580.0)	863.0
Low	3,266.0	17,643.0	(1,039.0)	4,040.0
High	3,556.0	21,461.0	(888.0)	4,872.0

Note: Parentheses indicate surplus.

IFPRI's estimate of the Sahel's import gap is much higher than either FAO's 1985 trend projection or any of our scenarios.

The reason is that their projected production is much lower. Production growth rates used to project supply are negative for several countries—probably reflecting the impact of the drought in 1975 (the end of the data series used to calculate production trends). FAO analyzed supply for specific commodities, and obtains negative production growth rates for some (wheat and millet), the overall growth rate is positive. Our projections, using commodity specific estimates and a longer historical period, also yield positive growth rates, although lower real producer prices mean lower growth rates under T74 conditions.

The differences in West Africa are more complex. Both IFPRI and FAO have different income elasticities for roots and tubers. FAO's is negative, while IFPRI assumes an income elasticity of 0. Our estimation of elasticities, however, found a significant, positive elasticity for RTP. While we included plantains, omitted by FAO and IFPRI, this is probably not enough to explain the difference. There are indications that these commodities are not inferior goals in some parts of West Africa—and hence, will continue to be demanded as income increases. Our admittedly unstructured observations suggested a significant informal trades, with RTP being "imported" by wealthier countries (Nigeria, Gabon), sometimes at rather high prices.

Our projections of demand for wheat and rice are also higher than FAO's. IFPRI does not estimate commodity specific equations, so no direct comparison can be made. This reflects the high income elasticity demand for these products, and our longer base period which incorporates more of the Nigerian income growth associated with higher oil prices.

FAO (and presumably IFPRI) include millet and sorghum in their projections, while we deal only with millet. IFPRI's rsults include groundnuts— while the FAO totals and our projections do not.

Different demand structures imply different calorie availabilities, and hence, different cereal equivalent measure of total demand. A ton of RTP provides less calories than a ton of wheat; a ton of goundnuts more. Hence, our demand estimates are, on balance, lower than FAO or IFPRI's.

Our estimates of production also differ from IFPRI and FAO's. FAO's trend projections of growths are very optimistic. If current pricing policies, as reflected in our four scenarios hold, there will be little prospect for a 4.2 percent annual growth rate in cereal production over the next decade. IFPRI's supply estimate is also higher, but since their growth rates are roughly comparable to ours, differences reflect primarily different commodity coverage.

The conclusion, then, is that FAO's trend projection probably underestimates the import gap. Both IFPRI's constant 1975 and our C75, while different, are plausible, given different commodity coverage.

There are major differences between IFPRI's constant 1975 projection and FAO's trend projection for Central Africa. FAO shows a 1.5 million ton import gap, while IFPRI shows a 1.5 million ton surplus. The reason is that they give very different projections of supply. Without a detailed commodity breakdown, it is hard to see where the difference lies. It is, however, possible to compare our commodity composition with FAO's. The major difference is in the supply of root and tubers. FAO did not estimate root and tuber supply in its trend projection, and for comparability, we

inserted an extrapolation based on the average ratio of roots and tubers to cereals in the baseline data and FAO's MPD scenario. This number is undoubtedly too low. Our C75 projection indicates an overall surplus, but one significantly smaller than IFPRI's (479,000 tons). Given the great uncertainties about the quality of RTP data for this region, a rather wide range of results are plausible.

Since FAO groups East and Southern Africa, systematic comparisons across all projections can even be made at this level. Both our C75 are FAO's trend shows substantial import gaps (4.5 to 5.5 million tons), while IFPRI's deficit is less than 1 million tons. Our results suggest that a very substantial share of the East Africa 1990 import gap may come from a shortfall of RTP. This reflects, again, positive income elasticities for RTP. In Southern Africa, on the other hand, RTP are inferior goods, and extrapolating trends suggest a surplus. On balance, these cancel each other out. Aggregating these two quite different results gives a result similar to FAO's but makes real differences.

Production in East and Southern Africa, as we showed earlier, is quite sensitive to price. These impacts are not captured in either FAO or IFPRI's projections.

In Southern Africa, on the other hand, IFPRI's projected demand is substantially below ours. Much of the difference can be accounted for by their very low income elasticities for cereals (on the order of 0.1-0.2). Our estimations suggest elasticities of five to ten times this level for major cereal crops. The comparisons of alternative projections exercises suggest several general points. First, with little income growth and no

substantial change in food production, the import gap will be 11-12 million tons (cereal equivalent) by 1990. Second, except for the obvious importance of West Africa, the studies do not give consistent results on how the import gap is divided across regions. The most significant discrepancies are for East and Southern Africa. Here the impact of price, the structure of demand, and elasticity estimates must be carefully weighed.

The overall implications of projections are, however, clear. Even without significant income growth, the food import demand of Sub-Saharan Africa will rise dramaticially.

The financial problems associated with this import demand will be compounded by the fact that unmet food needs of about the same size will exist. If, as now seems likely, many countries experience declines in real income over the next decade, the problem of unmet food needs will be even worse. If growth follows either patterns set by 1965-75 experience or 1974-79 experience, income growth will significantly increase the import demand <u>without</u> signficantly reducing the need to deal on a non-commercial basis with large unmet food needs. Clearly, policies to increase domestic production are necessary.

FOOTNOTES

1/ Internal producer price series for RTP and pulses were unavailable for any region, and for wheat for some regions only.

2/ FAO, Agricultural Commodity Projections 1970-1980, vol. II, (Rome 1971) p. XXXIX.

3/ F. R. Moormann and W. J. Veldkamp, "Land and Rice in Africa: Constraints and Potentials," in I. W. Buddenhagan and G. J. Persely, (eds.) Rice in Africa (New York: Academic Press, 1978), p. 32.

4/ M. Arraudeau, "Rice Breeding in Malagasy Republic," in I. W. Buddenhagan and G. J. Persley (eds.), Rice in Africa (New York: Academic Press, 1978), p. 133.

5/ CRED, Marketing, Price Policy and Storage of Food Grains in the Sahel (August 1977); AID, Title III Program for Senegal (1979); FAO, Résumé des Conclusions et Récommandations de la Mission FAO (1979/80).

6/ Food and Feed Grain Institute, "Assessment of the Need, Impact, and Proposed Uses of 1980 P.L. 480 Title I Rice Sales to Sierra Leone," Report No. 80 (Manhattan, Kansas: December 1979).

7/ United Republic of Tanzania, Ministry of Agriculture, "Price Policy Recommendations for the 1978/1979 Agricultural Price Review, Annex 1, Cereals" (Dar es Salaam: August 1977).

CHAPTER VI. CONCLUSIONS

Sub-Saharan Africa's precarious food balance stems from a combination of demand and supply factors. Urbanization and income growth have interacted with one another to create a structure of demand in urban areas that is difficult to match from domestic production. One result has been imports on an increasingly costly scale.

Although many African governments have spoken hopefully of reducing their food imports, particularly of wheat and rice, there is obviously a limited potential for doing so without risking political retribution. In this situation, governments have two other options: first, attempting to shift tastes and preferences of urban consumers away from imported foods and in the direction of domestically-produced foods through information campaigns, and second, attempting to make domestically-produced foods more palatable and, especially, convenient, to urban dwellers through improved processing techniques. The first of these options would appear to be more applicable in the Sahel and East Africa, where strong tastes for imported food staples have developed, while the second would appear to apply particularly to RTP in Central Africa, for which our research indicates an income preference exists.

To the extent that African governments are forced to reduce their imports of foods, it needs to be recognized that urban markets will continue to require adequate servicing, either from imports or domestic production, or a combination of both. From the urban consumer's viewpoint, the cost of imported food is likely to be higher in the coming decade, and the cost of domestically-produced food is also likely to remain higher than that of imports. Thus, governments face the necessity of continuing to incorporate food subsidies in their budgets. More research is needed on urbanization, which it is safe to say will be a continuing phenomenon in the 1980's, and on how and why urban consumers form

their food preferences, so that governments will be in a position to make informed policy choices in this sensitive area. Improvements in transportation infrastructure and food processing capacity are imperative policy instruments here.

While population migrates from countryside to town in Africa, the reverse flow of urban demand for food to rural producers is very weak. Because governments have hitherto been able to rely on imports to fill major urban demand from cities on coasts and waterways, the rural producing areas have been effectively isolated from linkage effects that in other parts of the world have resulted in agricultural development. The subsistence sector, which accounts for the great bulk of food production in Africa, remains largely a closed one responding in great part to the food needs of the immediate local population. Cash crops and off-farm labor earnings provide necessary ready cash. Response to incentives in food crop production is at the margin.

This situation will have to be drastically changed if domestic food production is to be expected to play a larger role in meeting aggregate food needs of African countries. The generally low levels of productivity (in spite of demonstrations of high yield potential of additional inputs coming from agricultural experiment stations) implies a high degree of vulnerability to natural hazards from year to year. Moreover, the concentration of food crop production in relatively brief growing periods in semi-arid areas, and the difficulties of transportation almost everywhere, result in wide seasonal price fluctuations in local markets and give rise to profit-making by traders and hoarders.

Citing the undesirable effects of speculation in the food trade, governments have intervened in staple food markets by setting procurement

prices, attempting to enforce monopoly procurement, and creating barriers to the free movement of foods. The result has frequently been to aggravate regional imbalances of food and to exaggerate price instability. Costs to governments in these operations are high. Costs to producers are high as well, since the grain procured on government order corresponds only roughly to a marketed surplus, many producers selling only in order to pay off debts in the expectation of buying back later in the year so as to get through the "hungry" season.

Where the transportation infrastructure is at its most rudimentary, or where it has been allowed to deteriorate since independence as in the Central African countries, producers in aggregate did not exhibit price responsiveness (see table 62). Here, it is obvious that marketing costs are exorbitant and government efforts to set producer prices will be ineffective as a means of stimulating output, except when combined with other, costly investments from national budgets.

On the other hand, in countries with relatively well integrated marketing networks, producers of staples for which there exists a strong demand in urban areas (and here we take account of provincial towns as well as capitals), like rice in West Africa and in Madagascar and Mozambique, have been shown to be price responsive and consequently government investments in irrigation infrastructure (Scenario 1) or reduction of the fertilizer-rice price ratio (Scenario 2) can bring about large changes in output.

Even assuming, for a moment, the existence of appropriate incentives to producers, the African countries lack the physical and human resources to produce sufficient additional quantities of staples to replace the totality of their imports, were maize, millet, and other African crops completely substitutable for imported rice and wheat. Scenarios 4 and 5 show clearly

the enormous expansion of cropped area that would be required to fill the import gap under present conditions of production. Assuming that yield-increasing packages of new technology were available, the financial resources necessary to sustain such an increase in production are lacking (except possibly in Nigeria). In other words, some portion of the import gap can possibly be closed in the coming decade, but not the whole gap.

In this situation, no magic solution exists. Upgrading the productivity of the large-farming sector and that of the subsistence sector both pose problems to government, some of them common to both. Any increase in productivity implies a heavier use of fertilizer, pesticides, and other purchased inputs, and this runs the risk of creating a new dependence on foreign sources of supply to replace an old one, in whichever sector the inputs are used. The logistical problems of delivering inputs to the subsistence sector in African countries are obviously greater than delivering them to relatively few large farms. On the other hand, the ecological consequences of clearing land for large farms in the present circumstances of limited knowledge of tropical soils may be costly as well. Moreover, government investments in large-scale farming in an effort to by-pass the subsistence sector and achieve high growth rates of food production will inevitably leave in place an impoverished rural population to feed a never-ending stream of migrants to the cities. In either case, the managerial demands of designing and implementing policy are likely to be great.

Narrowing the food gap will require a combination of incentives to producers and a workable procurement system (in relative proportions depending on the emphasis placed on each production sector), massive government investments in productive infrastructure, training and extension services, and an upgrading of research programs. Some estimates of the costs of these

investments have been given in Chapter III. Our research indicates, however, that the priorities given these investments should probably not be ranked identically for the whole continent, but should vary from region to region in accordance with resource dndowments and agricultural structure.

Improving the productivity of resources in the subsistence sector implies a transformation of the subsistence sector itself, since labor and land, the main productive resources here, are deeply embedded in the socio-economic framework in which production takes place. The transformation will necessarily be in the direction of a much more heavily commercialized structure. This may seem paradoxical in an environment where markets are far from perfect, uncertainty prevails, and the prices farmers receive for their product are notoriously low compared to the prices at the next point of sale. Indeed, the tendency to revert to autarky appears today wherever marketing links are disrupted by political upheaval or sharp reversals of government agricultural prices.

Such a transformation, however, can take several forms. It need not take the form, for instance, of production of surpluses of staple grains for which the income elasticity of demand is low. In East Africa higher productivity of food production per hectare could allow farmers to allocate more land to the production of traditional cash crops, in conditions where government policy-makers saw income generation in rural areas to be a desirable goal in itself. A similar change in West Africa could well take the form of more land allocated to production of maize, a non-traditional cash crop in much of the region, for commercial sale. And in the Sahel, it might allow marginal land to be taken out of production altogether, or fallow periods to be lengthened at least.

The introduction of new technology is a major means of raising the

productivity of resources in food production. The development of such new technology should rank high on the list of priorities in all regions. Careful thought needs to be given to the design of research programs, however, so that they do not lead to unfulfilled promises as in the past. The design needs to take into account the structure of African agriculture (most notably the relative factor endowments), as well as the limiting characteristics of soils and crops. The technology needs to be relatively self-contained, and not dependent on a heavy supporting infrastructure. New crop varieties whose performance improvement consists entirely of reducing the variability of yields can have a significant impact on production (Scenario 3). Likewise, better linkage between information on consumer preferences and research on new crop varieties may ease the tendency of people with higher incomes to shift away from traditional staples.

Bringing about the transition to a more commercialized system of food production in a manner such as to avoid creation of large unmarketable surpluses and other such man-made problems hinges greatly on the timing of government policies and on the skill with which their implementation is handled. Relative prices may become more important, as well as the ability to handle a wide range of crops. This implies close coordination of storage and trade policies with production policies.

Flexibility in input deliveries will be important. Input subsidies have a role to play, at the early stage of the transition, in shaping production patterns, generating rural income, and creating effective demand. This means that input subsidies should be used by African governments in a different way than they are used at present, that is to say to increase production of export crops and thus to generate short-term benefits to producer and government. Instead, they should be used to capture linkages within the

rural production sector. Given the high costs of transportation and marketing, what may appear to be a high operating cost (in terms of food supply) may actually be an economic benefit. At a later stage of the transition, input subsidies, which are relatively expensive for governments to sustain, may be reduced or dropped altogether.

The development of agricultural processing industries is another way of generating income in rural areas and creating linkages to national economies which do not exist at present. The successful processing of roots and tubers in Central African countries, for instance, would represent a real gain in transportation costs, and would meet a demand for a more convenient food in urban areas.

We have drawn the following specific conclusions from our analysis:

1. In the near term, the coordination of government policies in food production, marketing, and trade offers the best hope of meeting food needs in Sub-Saharan Africa. At the same time, it must be recognized that the timing of the application of these different policies will need to vary from one region to another, and that there are countries where the realization of production potential depends far more on a single special factor (such as provision of inputs in Kenya) than on others. This question of the coordination of policies and their timing does not respect national borders: a policy success in one country may have repercussions, beneficial or harmful, in neighboring countries.

2. Shifting urban consumer tastes and introducing new processing technologies for foods to make them more palatable and convenient afford some scope for replacing a portion of imports with domestic production. Programs along these lines will have a beneficial impact in terms of the attainment of self-sufficiency in food by some countries, and of generating

employment in all countries where they are tried. The process of servicing urban markets, viewed by us as a necessity, can thus create linkages in rural areas where none exist at present.

3. The transformation of the subsistence sector, in ways that raise living standards and respect social values, should, and indeed must, be a long-term goal of African governments, both from the point of view of increasing food production and of generating employment and income. Such a transformation is a precondition of building on integrated national economy. It must be based on improving productivity in food production, which is the key to reversing present deteriorating trends of food supply. Increased productivity in food production can be expected to lead, either directly or indirectly, to higher rural income, and decreased drudgery of farm work. Rural purchasing power in turn will induce an infusion of consumer goods into rural areas, and act as a further stimulate to higher productivity. The isolation of the subsistence sector will then have been broken.

4. We have taken a time frame of ten years in the present study. But in the longer term, a solution of the food problem in Sub-Saharan Africa probably depends on basic investments in education and research. Policies and programs suggested above will inevitably be self-limiting unless they are backed up by an appropriate set of local institutions. Such institutions must bear the burden of raising the presently low status of agriculture so as to upgrade human capital in food production, and of finding the answers to basic, unanswered questions about the capability of soils and crops to sustain a highly productive agriculture. Investments of this nature often do not have a high annual pay-off, which may make them unattractive in the short term. The alternative, however, is an indefinite continuation of ad hoc policymaking.

APPENDICES

Appendix A

Key to Map

"Climatic Regions"

(fig. 9)

	Climate	Temperature regimes [1]	Humidity regimes [1]	Main locations
	TROPICAL			
1.1	Humid semihot equatorial	Eq	HU Hu MO humidity index > 1	Congo basin, Gabon, Ivory Coast basin, Niger delta, east and northwest coasts of Madagascar
1.2	Humid semihot tropical	Tr	Hu MO humidity index > 1	Lower Congo, southeast coast of Madagascar, Zambezi delta
1.3	Dry semihot tropical	Eq Tr	humidity index 0.44 to 1.00	Coastal Mozambique, Tanzania and Angola; west coast of Madagascar
1.4	Hot tropical	EQ TR	MO Mo	Northern Guinea, Ivory Coast and Ghana; southern Mali, Benin, central Nigeria, the Central African Empire, southeastern Congo, interior of Mozambique, western Madagascar, upper Lualaba basin
1.5	Semiarid tropical	EQ Eq TR Tr	mo	Northern Senegal, Mali, southern Niger, Chad and Sudan, Somali coast, Lake Rudolf region, coastal Angola, southern Madagascar
1.7	Humid tierra templada	Tt tt	Hu Mo	All highlands in northern Angola, southern Zaire, Cameroon, southern Guinea, Ethiopia, Mozambique and Tanzania, scarps of the high plateaus of Madagascar
1.8	Dry tierra templada	Tt tt	Mo mo	Tanzania, Kenya, Uganda, region east of the Ethiopian high plateaus
1.9	Cool winter hot tropical	tR	HU Hu MO Mo mo	Northeastern Nigeria, eastern Chad and northern Central African Empire; southern scarps of the high plateaus of Madagascar
	TIERRA FRIA (possibility of frost)			
2.1	Semitropical tierra fría	TF, Ct in winter	Hu MO Mo mo	Much of the plateau area in Angola and central western Africa, eastern Malawi
2.2	Low tierra fría	TF, Ci or Av in winter	Hu MO Mo mo	All high plateaus of Madagascar, northern South Africa, Rhodesia and Shaba region in Zaire
2.3	Medium tierra fría	Tf	Hu MO Mo mo	Highlands of Ethiopia, Madagascar, South Africa, Kenya; northern Malawi
2.4	High tierra fría	tf	Hu MO Mo mo	Lesotho
	DESERT			
3.1	Hot tropical desert	EQ TP tr	da de do	Northeastern Sudan, Somalia, northeastern Kenya, coastal Mauritania, southeastern and northeastern Ethiopia
3.2	Hot subtropical desert	Ts SU	da de do	Sahara, Kalahari, western Africa, Libyan desert, northern Sudan
3.3	Semihot and cool tropical desert	Eq Tr tr	da de do	Coastal Mauritania, Spanish Sahara, southwestern Angola and northern Namibia
3.4	Cool subtropical desert	Su MA Mm	da de di do	Coastal Namibia, the Karroo region in South Africa, and the Gulf of Sidra in
3.5	Tropical highland desert	TF Tf tf	da do	Somali-Ethiopian border, central Namibia, two regions in central South Africa
3.8	Pampean desert	PA	da de di do	Northern Karroo region in South Africa
	SUBTROPICAL			
4.2	Monsoon subtropical	SU Su	Mo mo	Southeastern Rhodesia, northern Botswana and Namibia, southern Angola
4.3	Hot semitropical	Ts, G in summer	MO Mo mo	Zambezi basin between Senanga and the Kariba dam, Darfur and Kordofan in Sudan
4.4	Semihot semitropical	Ts, g in summer	Hu mo	East coast of South Africa and the region north of Swaziland
	PAMPEAN			
5.4	Marine pampean	MA	St	Southern coast of South Africa
5.6	Monsoon peripampean	PA	mo	High Veld in South Africa
5.7	Semiarid peripampean	Su	si	Between the Suurberge and Winterberge mountains in South Africa
	MEDITERRANEAN			
6.1	Subtropical Mediterranean	Su su	ME Me	Lowlands of southwestern South Africa, great plains of Morocco, coastal strip of Algeria and Tunisia, Tripolitania and Cyrenaica in Libya
6.2	Marine Mediterranean	MA Mm	ME Me	Cape area in South Africa, Safi region in Morocco
6.5	Temperate Mediterranean	TE	ME Me	Rif region in Morocco
6.7	Continental Mediterranean	CO Co co	ME Me	High Atlas in Morocco, Algerian high plateaus
6.8	Subtropical semiarid Mediterranean	SU Su Tr tr MA	me	Souss plain in Morocco, Sousse region in Tunisia, Tripolitania in Libya, coastal plain of Egypt, southern coastal plain of South Africa
6.9	Continental semiarid Mediterranean	CO Co co TE Te te	me	Desert fringe of the High Atlas, Algerian high plateaus, Tebessa mountains in Tunisia and Hodna mountains in Algeria.

Appendix A
(Continued)

IV. Humidity regimes

Symbol	Humidity regime	Definition
Hu	Humid	No dry month.[a] Humidity index[a] > 1. Ln[a] > 20% of potential evapotranspiration.[1] One or more months are not humid.[a]
ME Me me	Mediterranean	Neither humid nor desert, winter rain > summer rain. If summer is G, July should be dry. Latitude > 20°, otherwise the regime is monsoon.
Me	Dry Mediterranean	Ln[a] < 20% of annual evapotranspiration. Humidity index 0.22 to 0.88. In a month or more with daily maxima averaging above 15°C, water stored in the soil fully covers evapotranspiration.
me	Semiarid Mediterranean	Too dry for Me.
MO Mo mo	Monsoon	Neither humid nor desert. Humidity index[a] for July-August greater than for April-May. July or August is humid if two winter months are humid. July or August is not dry if two winter months are not dry. Otherwise the regime is steppe or semiarid isohygrous.
MO	Moist monsoon	Ln[a] > 20% of annual evapotranspiration and/or a humidity index[a] > 0.88.
Mo	Dry monsoon	Ln[a] < 20%. Humidity index[a] between 0.44 and 0.88.
mo	Semiarid monsoon	Humidity index[a] < 0.44.
da de do	Desert	All months with an average maximum temperature > 15°C are dry. The humidity index[a] is < 0.22.
da	Absolute desert	All months for which the average of the maxima is above 15°C have a humidity index[a] below 0.25. The annual humidity index is < 0.09.
de	Mediterranean desert	Not dry enough for da. Winter rains are heavier than summer rains.
do	Monsoon desert	Not dry enough for da. July-August are less dry than April-May.
si	Semiarid isohygrous	Too dry for the steppe regime, too humid for desert; neither Mediterranean nor monsoon regime.

I. Winter types

Symbol	Agricultural suitability	Average of the absolute minima of coldest month	Average of daily minima of coldest month	Average of daily maxima of coldest month
		Degrees Centigrade		
Ec	Warm enough for equatorial crops (rubber, coconut)	> 7°	> 18°	
Tp	Colder but frostless, too warm for cryophilous plants (wheat)	> 7°	13 — 18°	> 21°
tP	Idem, but wheat not entirely excluded	> 7°	8 — 13°	> 21°
Ct	Frost a possibility, but mild enough for citrus, marginal for cryophilous plants	— 2.5 to + 7°	> 8°	> 21°
Ci	Idem, but cool enough for cryophilous plants	— 2.5 to + 7°		10 — 21°
Av	Colder, but mild enough for winter oats	— 10 to — 2.5°	> — 4°	> 10°
av	Idem, but winter days are cooler	> — 10°		5 — 10°

II. Summer types

Symbol	Agricultural suitability	Duration of frostless season	Average of the mean daily maxima of warmest months n=number of months	Average of daily maxima of warmest month	Average of daily minima of warmest month
		Months	*Degrees Centigrade*		
G	Warm enough for cotton, summer days very hot	> 4.5	> 25° n = 6	> 33.5°	
g	Idem, but summer days less hot	> 4.5	> 25° n = 6	< 33.5°	> 20°
c	Warm enough for maize and cotton, nights cool but frostless, good for coffee growing	12	> 21° n = 6	< 33.5°	< 20°
O	Colder, but warm enough for rice	> 4	21-25° n = 6		
M	Colder, but warm enough for maize	> 4.5	> 21° n = 6		
T	Colder, but warm enough for wheat	> 4.5	< 21° n = 6 or > 17° n = 4		
t	Colder, but warm enough for wheat, short frostless season	2.5 — 4.5	> 17° n = 4		

III. Temperature regimes

Symbol	Temperature regime	Winter type	Summer type
EQ	Hot equatorial	Ec	G
Eq	Semihot equatorial	Ec	g
TR	Hot tropical	Tp	G
Tr	Semihot tropical	Tp	g
tR	Cool winter hot tropical	tP	G, g
Tt	Tierra templada	Tp, tP, tp	c
TF	Low tierra fria	Ct or colder	g
Tf	Medium tierra fria	Ci or colder	O, M
tf	High tierra fria	Ci or colder	T, t
Ts	Semitropical	Ct	G, g
SU	Hot subtropical	Ci, Av	G
Su	Semihot subtropical	Ci	g
MA	Warm marine	Ci	O, M
TE	Warm temperate	av, Av	M
PA	Pampean	Av	M
CO	Warm continental	Av or colder	g, G

Appendix B

TECHNICAL TERMS ON MAIZE BREEDING

Hybrid--A single, double or triple cross of selected inbred lines, normally, with wide variability in genetic background, that attempts to enhance certain predetermined characteristics such as yield insect or disease resistance, stalk strength, and attain hybrid vigor or heterosis.

Synthetic-- An open pollinated variety derived from the combination of a number of selected self-pollinated lines, the good combining ability of which has been predetermined by testing all possible first generation (F1) combinations.

Composite--An open-pollinated variety selected from the random combination of a large number of recognized breeding lines that in theory have good combining quality and the genetic characteristics desired for a specific location.

Synthetic and composites are generally developed for adverse or marginal maize growing conditions or where demand for maize seed is not sufficient to make hybrid seed production viable.

The hybrid H611 was the result of crossing a synthetic, Kitale Synthetic II, with an Ecuadorian line, EC573, acquired in germ plasm collection work.

Appendix C

PROJECTIONS

Any economic policy requires some information about the probable direction and magnitude of relevent economic quantities in the future. Thus, projection is an extremely important means of economic policy. This knowledge is especially valuable in the analysis of supply and demand for food, where disequilibrum can lead to famine accompained by a significant change in economic structure.

This study provides projected values of the demand and supply of grains, roots, and pulses for Sub-Saharan Africa, disaggregated by region.

It is important to note that projections are basically conditional forecasts, since the relationship between the variables may not be stable over the period of forecast. In general, a projection involves the estimation of the value of the dependent variable at a future date, given the value of explanatory variables at their future values. It is important to note that the values of the explanatory variables are also arrived at by projections.

In this study, the basic forecasts are based on four different sets of assumptions concerning the values of the exogenous variables. These are constant real price and per capita income at 1975, constant real price and per capita income at 1979, 1965-79 trend of incomes and prices and finally 1974-79 trend of incomes and prices.

On the <u>supply side</u> of the model, projection procedures involve the following steps:

1. Forecasting area harvested for 1989 by mean of double-logarithmic functions.

$$\log A_t = a + \log t$$

where: A_t = area harvested
t = Time trend (1965-79)

2. Risk factor is a function of the variability of crop yield, and yield variation is assumed to be random and normally distributed. Consequently, the mean value of risk factor for the period of 1965-79 was used as the best estimate of risk in 1990.

3. Price

(a) Constant price at 1975 or 1979 level--The constant real price simply means that the ratio of the price to the cost of living which is represented by consumer price index (CPI) stays the same in 1990 as it was in 1975 and 1979. To calculate constant real price, the price index of all countries in a region was converted to a common base year (1970 = 100). The average price index of the countries in a region was used to represent the CPI for that region. The future value of the CPI was forecasted using double logarithmic function and time trend as explaratory variable. The following formula was used to get the future real price for a commodity.

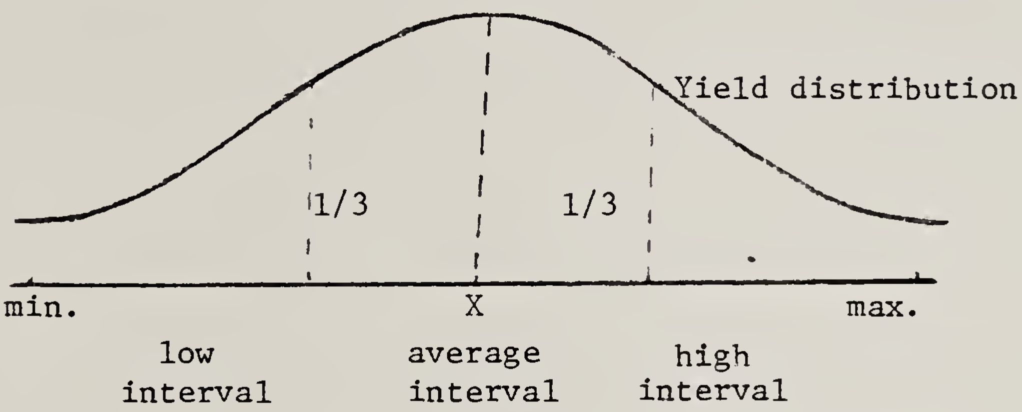
$$\frac{P_t}{PINX_t} = \frac{P_{t+s}}{PINX_{t+s}}$$

where: P = Price of a commodity
PINX = Consumer price index
t = 75 or 79
t+s = future date, 89 (lagged price was used in area equation)

(b) Price trend--The trend value was simply estimated by extrapolation of the expanantial growth for 1989. The time period used was 1965 to 79.

4. The expected yield was used in the supply equation to forecast the future level of production. The probability distribution of yield was used to get the mathematical expection of yield for each crop in a region. (Appendix Table 11). To estimate the probability distribution, the range of yields for 1965-79 was divided into three intervals. The low interval is defined by a lower bound of the minimum yield and an upper bound equal to two-third of the interval from the minimum to the mean. The average interval covers one-third of the distance from the minimum and maximum and centers

around the mean. The high interval covers the distance of the one-third from the mean to the maximum yield attained in the period of 15 years (see graph). The probability distribution of each interval and their corresponding means are used to calculated the expected yield for each crop in a region.



The demand side of the model also provides 4 basic sets of projections: constant real price and income at 75 and 79 levels, trend, and the fourth projection of trend based on data of 1974-75.

The projected value of income at constant per capita real income of 1975 and 1979 was based on the consumer price index. Again, the calculation was based on keeping the ratio of per capita income and cost of living (represented by the CPI) at the 1975 and 1979 level. The forecast of population was used to estimate total income in 1990. The projected income based on trend was calculated using a double log function for the period 1965-79.

The projected price used on the demand side was forecasted using the same procedure as the supply side. The only difference was that the price used in demand equations was the 1990 price, whereas 1989 was used in the supply sides.

APPENDIX TABLES

List of Appendix Tables

Appendix table 1--Available resources and inputs for agricultural production, by region and country, Sub-Saharan Africa, 1977

Region and country 1/	Population 2/	Percentage of labor force in agriculture 3/	Number in primary school as percentage of age group	Per capita GNP 3/	Area 3/	Cropland as a percentage of total land 4/	Irrigated land as a percentage of cropland 4/	Population per km² of cropland 4/	Km of roads per km² of total land 5/	Fertilizer Nutrient Use 6/
	Million	- - - Percent	- - -	U.S. dollars	1,000 km²	- - - Percent	- - -	Number	Percent	Metric tons
Sahel	27.9	85	1/29	190	5,307	7.6	0.7	69.6	1/1.6	76,231
Cape Verde	0.3	58	N.A.	180	4	9.9	5.0	750.0	N.A.	N.A.
Chad	4.2	87	41	130	1,284	5.6	.01	60.0	2.1	6,572
Gambia	.5	79	N.A.	220	11	26.5	10.0	200.0	2.2	2,950
Mali	6.0	89	28	110	1,240	8.0	1.0	61.1	1.3	13,000
Mauritania	1.3	84	N.A.	270	1,031	0.2	4.0	682.7	0.59	1,200
Niger	4.7	92	21	160	1,267	11.8	.2	31.6	.6	809
Senegal	4.6	77	45	430	196	12.5	5.3	192.8	7.1	45,050
Upper Volta	6.3	84	16	130	274	20.5	.04	112.5	5.2	6,650
West Africa	104.8	60	1/57	400	2,594	22.1	1/.2	182.9	9.7	178,382
Benin	3.2	47	53	200	113	26.2	.2	110.1	2.9	1,500
Cameroon	6.7	74	120	340	475	15.7	.1	90.3	6.1	22,225
Ghana	10.5	54	44	380	239	11.8	.7	386.9	13.5	25,050
Guinea	4.6	83	N.A.	220	246	17.0	.1	111.3	3.1	1,450
Guinea Bissau	.9	84	N.A.	280	36	10.2	N.A.	315.8	8.9	N.A.
Ivory Coast	5.1	82	87	690	322	28.8	.3	56.2	14.2	42,550
Liberia	1.8	73	62	420	111	3.9	.5	483.8	7.2	4,694
Nigeria	66.5	56	49	420	924	26.3	.08	279.5	11.6	76,500
Sierra Leone	3.1	68	37	190	72	57.2	.1	76.6	10.3	2,044
Togo	2.4	69	103	300	56	42.6	.2	104.1	12.5	2,369
Central Africa	36.3	72	1/84	260	4,584	3.3	N.A.	241.7	6.1	32,246
Angola	6.7	61	63	300	1,247	1.5	N.A.	364.4	5.9	16,050
Central African Rep.	1.9	89	79	250	623	9.5	N.A.	31.7	3.5	2,200
Congo	1.4	36	155	490	342	2.0	N.A.	212.3	2.4	2,380
Gabon	0.5	78	N.A.	5,250	27	1.7	N.A.	125.1	2.6	874
Zaire	25.8	76	86	130	2,345	2.7	N.A.	417.5	7.2	10,742
East Africa	103.2	82	45	200	6,184	6.1	5.0	275.5	2.3	184,856
Burundi	4.0	85	22	130	28	49.6	.4	311.6	27.9	646
Ethiopia	29.3	81	23	110	1,222	12.5	.4	213.6	.88	27,995
Kenya	14.2	79	105	270	583	4.0	1.9	623.9	8.7	52,709
Rwanda	4.4	92	61	130	26	38.3	.1	464.7	34.7	10,742
Somalia	3.3	83	40	110	638	1.7	15.5	312.5	2.1	50
Sudan	19.5	79	39	290	2,506	3.2	20.9	259.6	.42	56,000
Tanzania	16.4	84	70	190	945	5.8	1.1	321.1	3.6	34,568
Uganda	12.1	84	51	270	236	27.7	.1	217.7	2.9	2,128

See footnotes at end of table.

Continued--

Appendix table 1--Available resources and inputs for agricultural production, by region and country, Sub-Saharan Africa, 1977

Region and country 1/	Population 2/	Percentage of labor force in agriculture 3/	Number in primary school as percentage of age group	Per capita GNP 3/	Area 3/	Cropland as a percentage of total land 4/	Irrigated land as a percentage of cropland 4/	Population per km^2 of cropland 4/	Km of roads per km^2 of total land 5/	Fertilizer Nutrient Use 6/
	Million	- - - Percent - - -		U.S. dollars	1,000 km^2	- - - Percent - - -		Number	Percent	Metric tons
Southern Africa	38.4	76	1/90	310	4,073.1	4.4	1/3.4	208.5	5.7	234,216
Botswana	0.6	82	N.A.	522	569.8	2.3	.1	536.8	1.8	2,050
Lesotho	1.2	88	119	240	30.3	11.7	N.A.	338.0	12.9	1,400
Madagascar	8.1	84	92	240	587	5.0	15.0	276.5	4.7	9,600
Malawi	5.2	87	63	140	118	24.2	.4	226.8	10.7	22,416
Mozambique	9.7	68	90	150	783	4.0	2.2	314.1	3.4	12,850
Namibia	1.0	50	N.A.	1,200	823.6	.8	1.2	152.8	4.1	N.A.
Swaziland	0.5	75	N.A.	470	17.4	9.7	16.8	297.0	16.1	5,200
Zambia	5.3	69	95	450	753	6.8	.1	107.0	4.8	67,200
Zimbabwe	6.7	61	98	500	391	6.4	2.4	271.3	20.0	113,500

N.A. = Not Available.
1/ Data for regions include only countries for which data are available.
2/ Unpublished data, Economics, Statistics, and Cooperative Services
3/ World Bank, World Development Report, 1979.
4/ Food and Agriculture Organization, Production Yearbook, 1978. Cropland refers to land defined by the FAO as arable land and land under permanent crops. It includes land under temporary crops, temporary meadows for mowing and pasture, land under market and kitchen gardens, land temporarily fallow or idle, and land cultivated with crops that occupy the land for long periods and need not be replanted, such as rubber, cocoa, and coffee.
5/ Central Intelligence Agency, National Basic Intelligence Factbook, January 1980.
6/ Food and Agriculture Organization, Annual Fertilizer Review, 1979. Data for calendar year 1977 were calculated by averaging 1976-77 and 1977-78 data.

Appendix Table 2 --Food supplies in Africa by region and country
Sub-Saharan

Country	Staple foods 1/ Rural	Urban	Average daily per capita calorie intake as percentage of daily requirement, 1976-78 2/	Index of per capita food production, annual average 1976-78 (1961-65= 3/ 100)	Food self-sufficiency Ratio, annual average 1976-78 4/	Average annual food aid, cereals, 1976-78 5/	Average annual P.L. 480 food aid, 1976-78 6/	Average annual cereals imports, 1976-78 7/
	--Food item--		Percent	--Index--	--Ratio--	---1,000 metric tons---		
Sahel:								
Cape Verde	Maize	Maize	77	NA	NA	34.8	11.9	NA
Chad	Millet, sorghum	Rice, wheat	76	87	100	32.3	13.7	14.2
Gambia	Rice	Rice	101	8/95	52	10.5	3.2	40.9
Mali	Millet, rice, sorghum	Rice, wheat	76	83	99	26.5	7.9	30.8
Mauritania	Millet, sorghum	Rice, wheat	81	72	8/ 32	41.3	11.7	122.0
Niger	Millet, sorghum	Rice, wheat	85	85	97	43.2	12.9	23.4
Senegal	Millet, rice	Rice, wheat	108	76	59	89.1	28.0	154.4
Upper Volta	Millet, sorghum	Rice, wheat	71	67	97	35.8	20.2	39.0
West Africa:								
Benin	Maize, millet	Rice, wheat,	94	84	87	7.5	2.1	41.3
Cameroon	Maize, millet	Maize, millet	101	95	90	4.8	2.5	104.6
Ghana	Maize, cassava	Maize, cassava wheat	84	77	84	63.8	15.0	211.9
Guinea	Rice, cassava	Rice	83	101	85	39.3	7.8	54.8
Guinea-Bissau	Cassava, rice	Cassava, rice	100	NA	NA	27.7	6.1	NA
Ivory Coast	Cassava, millet	Cassava, rice,	116	130	75	0	0.4	243.3
Liberia	Rice	Rice, cassava	97	98	80	1.2	.6	61.3
Nigeria	Rice, maize, sorghum	Rice, cassava	86	87	91	.4	.4	925.0
Sierra Leone	Rice	Rice, wheat	97	97	90	8.5	9/ 4.1	37.7
Togo	Cassava, millet, rice	Rice, wheat,	95	98	100	12.0	8.1	NA
Central Africa:								
Angola	Cassava, maize	Cassava, wheat	69	59	NA	8.0	1.2	153.7
Central African Republic	Sorghum, maize, cassava	Wheat, rice	98	102	8/ 91	1.4	.8	11.5
Congo	Cassava, rice, maize	Rice, wheat	95	93	8 /40	3.2	2.4	60.8
Gabon	Cassava, plantains	Rice, wheat	NA	NA	NA	NA	.08	27.6
Zaire	Cassava, maize, wheat	Cassava, maize, wheat	83	103	70	29.3	1.1	381.6
East Africa:								
Burundi	Cassava, plantains, sweet potatoes, pulses, maize	Cassava, plantains, sweet potatoes, pulses	106	106	100	7.8	3.1	30.5

Ethiopia	Teff, maize, barley, sorghum, wheat	Teff, maize barley, sorghum, wheat	69	69	8/ 98	102.3	18.5	70.3
Kenya	Maize	Wheat, maize	96	95	102	8.8	3.1	43.1
Rwanda	Plantains, pulses, sweet potatoes, maize	Plantains, sweet potatoes pulses	82	102	100	12.8	4.5	6.5
Somalia	Maize, sorghum	Maize	77	8/ 90	NA	8/1.2	12.2	73.9
Sudan	Sorghum, wheat	Sorghum, wheat	93	117	99	82.5	10/ 5.9	88.8
Tanzania	Cassava, maize, rice	Wheat, rice, maize	81	106	93	108.1	25.1	108.1
Uganda	Plantains, pulses, millet, maize, sweet potatoes, cassava	Plantains, pulses, millet, maize sweet potatoes	80	75	100	0	.07	15.3
Southern Africa:								
Botswana	Maize, sorghum	Maize	73	111	8/ 71	5.9	5.5	8/ 39.5
Lesotho	Maize, wheat	Maize, wheat	95	100	8/ 78	19.1	13.0	63.3
Madagascar	Rice	Rice	107	103	87	9.3	1.3	174.6
Malawi	Maize	Maize	93	101	100	2.6	.6	40.2
Mozambique	Cassava, maize, wheat rice	Cassava, wheat, rice	73	82	89	101.8	8.2	192.0
Namibia	Mahangu	Maize	95	NA	NA	0	NA	NA
Swaziland	Maize	Maize	94	103	8/ 89	NA	.5	8/ 13
Zambia	Maize	Maize	95	141	NA	17.4	2.3	61.8
Zimbabwe	Maize	Maize	109	NA	NA	0	0	NA

Table 3 = Food supplies

NA = not available

1/ Economics Statistics and Cooperatives Service.

2/ U.S. Department of Agriculture, Economics, Statistics and Cooperatives Service, Global Food Assessment, 1979, Table I-2. In this report, per capita food intake was calculated as the quantity of food available for human use at the retail level after provision was made for changes in food stocks and the supplies of food traded, fed to livestock, used as seed or for individual purposes, or lost in collection, processing or marketing. Recommended caloric intakes are those established by the Food and Agriculture Organization and the World Health Organization in 1973.

3/ Same source as footnote 2 but table II - 3.

4/ The standard food self-sufficiency ratio is calculated as:

$$SSR_t = \frac{\text{per capita production of cereals}_t}{\text{per capita consumption of cereals}_t} \times 100.$$

The SSR for each country was calculated using data from the US Department of Agriculture, Global Food Assessment, 1979, Table II - 9 and the Food and Agriculture Organization Production Yearbook, 1978.

5/ Unpublished internal report, Food and Agriculture Organization, World Food Program. CFA: 915 (Spring, 1980), pp. 19-20. Data for 1976, 1977 and 1978 were calculated by averaging data for split years.

6/ U.S. Agency for International Development, Africa Bureau, Office of Development Resources. Food for Development in Subsaharan Africa, March, 1980. Statistics in this report were orginally from Food for Peace Annual Reports; Africa CP 1980 and other Food for Peace documents.

7/ Food and Agriculture Organization, Trade Yearbook, 1978; International Monetary Fund, International Financial Statistics; and World Bank, "Economic Data Sheets."

8/ 1976-77 average.

9/ Figure does not include $1.3 million worth of commodities for which the tonnage is unknown.

10/ Figure does not include $4.8 million worth of commodities for which the tonnage is unknown.

Appendix Table 3--Role of agriculture in economy for Sub-Saharan Africa by region and country

Country	Agriculture as percentage of GDP, 1977 1/	Urbanization: Percentage of total population, 1977 2/	Urbanization: Average annual growth rate, 1970-75 3/	Percentage of foreign exchange from -- (annual average, 1975-77): All cash crops 4/	Percentage of foreign exchange from -- (annual average, 1975-77): Major cash crops 4/	Major cash crops 4/
	Percent					Crops
Sahel:						
Cape Verde	NA	NA	NA	18.7	8.1	Bananas
Chad	52	16	6.8	57.9	56.3	Cotton
Gambia	50	NA	NA	95.2	94.5	Groundnuts
Mali	6/ 38	19	5.3	51.3	44.9	Cotton, groundnuts
Mauritania	26	26	14.4	NA	NA	NA
Niger	6/ 47	11	6.8	0.1	NA	NA
Senegal	6/ 28	24	8.0	55.5	50.9	Groundnuts
Upper Volta	37	9	3.6	63.4	47.8	Cotton, sheanuts
West Africa:						
Benin	32	NA	NA	72.45	57.5	Palm products, cotton
Cameroon	32	28	8.0	69.0	58.0	Cocoa, coffee
Ghana	39	33	5.1	70.5	59.2	Cocoa
Guinea	32	17	6.2	5/ 97.6	5/ 74.7	Coffee, palm products
Guinea-Bissau	NA	NA	NA	77.7	75.1	Groundnuts, palm products
Ivory Coast	6/ 25	35	9.3	67.1	62.5	Coffee, cocoa
Liberia	31	32	5.6	18.2	12.4	Rubber
Nigeria	34	18	4.6	5.5	3.8	Cocoa
Sierra Leone	40	23	5.6	34.2	20.7	Cocoa, coffee
Togo	23	16	5.4	33.6	28.5	Coffee, cocoa
Central Africa:						
Angola	49	19	5.7	10.0	NA	Coffee
Central African Republic	38	37	5.1	51.0	47.3	Cotton, coffee
Congo	6/11	37	3.0	8.3	6.8	Coffee, cocoa, sugar
Gabon	NA	20	NA	.006	.002	Cocoa
Zaire	6/ 25	26	5.4	20.0	NA	Coffee
East Africa:						
Burundi	64	2	17.0	94.2	89.7	Coffee
Ethiopia	52	13	7.0	78.5	54.7	Coffee, cotton
Kenya	41	13	7.0	53.9	42.4	Coffee, tea
Rwanda	46	5	5.6	65.3	56.1	Coffee
Somalia	NA	27	5.0	11.7	11.6	Bananas
Sudan	43	22	6.9	86.8	73.2	Cotton, groundnuts
Tanzania	6/ 44	10	8.5	80.4	45.2	Coffee, cotton
Uganda	54	11	8.5	96.3	81.3	Coffee
Southern Africa:						
Botswana	25	2	NA	0.01	.01	Pulses
Lesotho	36	4	8.1	12.5	10.0	Pulses
Madagascar	38	20	4.3	74.2	52.0	Coffee, vanilla,
Malawi	45	9	7.5	88.7	64.7	Tobacco,tea
Mozambique	56	7	6.8	80.0	NA	Cashews, cotton
Namibia	16	NA	NA	0	0	-
Swaziland	30	2	NA	80.0	36.0	Sugar, cotton
Zambia	14	40	5.4	1.2	.8	Tobacco
Zimbabwe	20	21	6.4	50.0	17.0	Tobacco, corn

N.A. = not available
1/ World Bank, World Development Report, 1979 and 1980, (Washington, D.C.) Table 3, and various World Bank documents.
2/ Economics, Statistics and Cooperatives Service; World Bank, World Development Indicators, 1979, Table 20.
3/ World Bank, World Development Indicators, 1979. Table 20.
4/ Food and Agriculture Organization, Trade Yearbook, 1978, pp. 303-18; and various World Bank documents.
5/ 1976-78 data.
6/ 1976 data.

Appendix table 4--Area equations

SAHEL

Rice:

$$LA_{rs} = 4.60 + .15LA_{r\ t-1} + .13LP_{r\ t-1}$$

t: (3.52) (.65) (1.92)

$R^2 = .62$ $D = 2.03$ Type = OLS

Maize:

$$LA_{cs} = 2.13 + .54LA_{c\ t-1} + .11LP_{t-1}$$

t: (1.32) (2.07) (.79)

$R^2 = .29$ $D = 1.76$ Type = OLS

Millet:

$$LA_{ms} = 3.98 + .45LA_{m\ t-1} + .19LP_{m\ t-1} - .02LR_{ms}$$

t: (3.12) (2.71) (4.11) (1.22)

$R^2 = .91$ $D = 2.39$ Type = OLS

Roots:

$$LA_{rs} = 3.58 + .48LA_{r\ t-1} - .01LR_{rs}$$

t: (3.69) (3.34) (.52)

$R^2 = .67$ $D = 1.95$ Type = OLS

Pulses:

$$LA_{ps} = 2.57 + .47LA_{p\ t-1}$$

t: (1.79) (1.59)

$R^2 = .17$ $D = .94$ Type = OLS

WESTERN

Rice:

$$LA_{rw} = 4.89 + .14LA_{r\ t-1} + .24LP_{r\ t-1} - .05LR_{rw}$$

t: (2.40) (.40) (2.79) (1.74)

$R^2 = .86$ D = 1.47 Type = OLS

Maize:

$$LA_{cw} = 4.91 + .30LA_{c\ t-1} + .11LP_{c\ t-1} - .04LR_{cw}$$

t: (2.71) (1.19) (1.95) (1.54)

$R^2 = .84$ D = 1.48 Type = OLS

Millet:

$$LA_{mw} = 6.13 + .27LA_{m\ t-1} - .06LR_{mw}$$

t: (4.08) (1.56) (4.44)

$R^2 = .73$ D = 1.24 Type = OLS

Roots:

$$LA_{rw} = 2.92 + .66LA_{r\ t-1} - .01LR_{rw}$$

t: (1.26) (2.38) (.46)

$R^2 = .56$ D = 2.62 Type = OLS

Pulses:

$$LA_{pw} = 2.18 + .56LA_{p\ t-1} - .05LR_{pw}$$

t: (1.34) (1.69) (.97)

$R^2 = .44$ D = 2.10 Type = OLS

CENTRAL

Rice:

$$LA_{rc} = 1.99 + .65LA_{r\ t-1} - .04LR_{rc}$$

t: (4.31) (7.69) (4.10)

$R^2 = .95$ D = 1.75 Type = OLS

Maize:

$$LD_{cc} = 1.22 + .83LA_{c\ t-1} - .02LR_{rc}$$

t: (1.25) (5.73) (.45)

$R^2 = .82$ D = 3.05 Type = OLS

Millet:

$$LA_{mc} = 1.27 + .77LA_{m\ t-1} - .02LR_{mc}$$

t: (1.39) (4.41) (.67)

$R^2 = .73$ D = 2.34 Type = OLS

Roots:

$$LA_{rc} = .25 + .97LA_{r\ t-1}$$

t: (.29) (8.46)

$R^2 = .86$ D = 1.91 Type = OLS

Pulses:

$$LA_{pc} = 1.59 + .28LA_{p\ t-1}$$

t: (2.3) (10.76)

$R^2 = .93$ D = 1.73 Type = OLS

EASTERN:

Wheat:

$$LA_{we} = 1.10 + .84LA_{w\ t-1} - .02LR_{we}$$

t: (.90) (4.94) (1.06)

$R^2 = .70$ D = 1.95 Type = OLS

Rice:

$$LA_{re} = 2.29 + .19LA_{r\ t-1} + .42LP_{R\ t-1}$$

t: (2.61) (.84) (2.88)

$R^2 = .67$ D = 2.24 Type = OLS

Maize:

$$LA_{cg} = 3.21 + .56LA_{c\ t-1} + .10LP_{C\ t-1}$$

t: (2.56) (3.15) (1.43)

$R^2 = .83$ D = 2.74 Type = OLS

Millet:

$$LA_{me} = 3.80 + .46LA_{m\ t-1} + .09LP_{m\ t-1}$$

t: (2.10) (1.79) (1.73)

$R^2 = .73$ D = 1.72 Type = OLS

Sorghum:

$$LA_{se} = 7.49 + .05LA_{s\ t-1} + .27LP_{S\ t-1}$$

t: (2.99) (.13) (2.12)

$R^2 = .58$ D = 2.12 Type = OLS

EASTERN:

Wheat:

$$LA_{we} = 1.10 + .84LA_{w\ t-1} - .02LR_{we}$$

t: (.90) (4.94) (1.06)

$R^2 = .70$ D = 1.95 Type = OLS

Rice:

$$LA_{re} = 2.29 + .19LA_{r\ t-1} + .42LP_{R\ t-1}$$

t: (2.61) (.84) (2.88)

$R^2 = .67$ D = 2.24 Type = OLS

Maize:

$$LA_{cg} = 3.21 + .56LA_{c\ t-1} + .10LP_{c\ t-1}$$

t: (2.56) (3.15) (1.43)

$R^2 = .83$ D = 2.74 Type = OLS

Millet:

$$LA_{me} = 3.80 + .46LA_{m\ t-1} + .09LP_{m\ t-1}$$

t: (2.10) (1.79) (1.73)

$R^2 = .73$ D = 1.72 Type = OLS

Sorghum:

$$LA_{se} = 7.49 + .05LA_{s\ t-1} + .27LP_{s\ t-1}$$

t: (2.99) (.13) (2.12)

$R^2 = .58$ D = 2.12 Type = OLS

Roots:

$$LA_{re} = 1.59 + .79LA_{r\ t-1}$$

t: (2.19) (8.20)

$R^2 = .85$ D = 1.72 Type = OLS

Pulses:

$$LA_{pe} = 2.29 - .69LA_{p\ t-1}$$

t: (2.78) (6.00)

$R^2 = .75$ D = 3.0 Type = OLS

<u>SOUTHERN</u>

Wheat:

$$LA_{ws} = 2.57 + .42LA_{w\ t-1} - .07LR_{ws}$$

t: (2.39) (1.82) (1.36)

$R^2 = .33$ D = 1.80 Type = OLS

Rice:

$$LD_{rs} = 2.74 + .51LA_{r\ t-1} + .15LP_{r\ t-1} - .03LR_{rs}$$

t: (2.36) (2.19) (1.09) (1.13)

$R^2 = .83$ D = 2.38 Type = OLS

Maize:

$$LA_{cs} = 3.09 + .38LA_{c\ t-1} + .45LP_{c\ t-1} - .07LR_{cs}$$

t: (3.52) (2,48) (2.82) (1.56)

$R^2 = .87$ D = 2.27 Type = OLS

Millet and Sorghum:

$$LA_{ms} = 4.26 - .33LA_{m\ t-1} + .09LP_{m\ t-1} - .01LR_{ms}$$

t:	(2.50)	(1.22)	(1.60)	(.95)

$R^2 = .63$ D = 2.30 Type = OLS

Roots:

$$LA_{rs} = .92 - .86LA_{r\ t-1} - .01LR_{rs}$$

t:	(1.00)	(6.20)	(.65)

$R^2 = .96$ D = 1.26 Type = OLS

Pulses:

$$LA_{ps} = 3.20 + .27LA_{p\ t-1} - .03LR_{ps}$$

t:	(3.08)	(1.17)	(2.13)

$R^2 = .37$ D = 1.78 Type = OLS

Appendix table 5--Demand equations

SAHEL

Wheat:

$$LD_{ws} = 5.90 + .9241y_s - .297LP_{wu}$$

t: (3.15) (1.25) (0.65)

$R^2 = .79$ D = 1.84 Type = CORC

Rice:

$$LD_{rs} = 7.28 + .927LY_s - .353LP_{rs} - .271D_s$$

t: (9.46) (4.69) (1.65) (6.79)

$R^2 = .95$ D = 1.81 Type = OLS

Maize:

$$LD_{cs} = 4.38 + .46LY_s - .993D_s$$

t: (5.67) (1.41) (1.32)

$R^2 = .73$ D = .62 Type = CORC

Millet:

$$LD_{ms} = 8.16 + .154LY_s - .06LP_{ms} - .09\ D_s$$

t: (26.08) (1.52) (.63) (2.98)

$R^2 = .71$ D = 2.33 Type = CORC

Roots:

$$LD_{rs} = 6.698 - .036LY_s - .081D_s$$

t: (212.38) (1.12) (3.96)

$R^2 = .78$ D = 2.03 Type = CORC

Pulses:

$$LD_{ps} = 4.93 - 0.139LY_s - .083D_s$$

t: (14.63) (2.91) (2.26)

$R^2 = .57$ D = 1.46 Type = OLS

WESTERN

Wheat:

$$LD_{ww} = 5.03 + .0871LY_w - .155LP_{wu}$$

t: (6.97) (7.31) (0.78)

$R^2 = .92$ D = 1.78 Type = OLS

Rice:

$$LD_{rw} = 8.73 + .645LY_w - .526LP_{RW}$$

t: (12.83) (6.05) (2.99)

$R^2 = .94$ D = 1.87 Type = CORC

Maize:

$$LD_{cw} = 7.705 + 0.148LY_w - .055LP_{cw}$$

t: (32.75) (2.54) (.74)

$R^2 = .96$ D = 1.82 Type = CORC

Millet:

$$LD_{mw} = 7.672 + 0.09LY_w$$

t: (13.40) (2.40)

$R^2 = .62$ D = 1.80 Type = CORC

Roots:

$$LD_{rw} = 10.37 + .12LY_w$$

t: (71.28) (3.07)

$R^2 = .98$ $D = 1.56$ Type = CORC

Pulses:

$$LD_{pw} = 3.17 + .424LY_w$$

t: (21.53) (8.08)

$R^2 = .96$ $D = 1.94$ Type = CORC

<u>CENTRAL</u>

Wheat:

$$LD_{wc} = 4.97 + .55LY_c$$

t: (48.00) (5.99)

$R^2 = .76$ $D = 1.35$ Type = OLS

Rice:

$$LD_{rc} = 6.48 + .93LY_c - .52LP_{RC}$$

t: (6.21) (3.60) (1.81)

$R^2 = .77$ $D = 1.34$ Type = OLS

Maize:

$$LD_{cc} = 7.54 + .66LY_c - .38LP_{cc}$$

t: (6.60) (3.83) (1.21)

$R^2 = .85$ $D = 1.45$ Type = OLS

Millet:

$$LD_{mc} = 5.56 + .28LY_c - .22LP_{mc}$$

t: (4.85) (1.97) (.72)

$R^2 = .36$ D = 1.40 Type = OLS

Roots:

$$LD_{mc} = 10.47 - .21LY_c$$

t: (18.15) (1.95)

$R^2 = .92$ D = .59 Type = CORC

Pulses:

$$LD_{pc} = 5.67 - .14LY_c$$

t: (23.25) (1.84)

$R^2 = .67$ D = .83 Type = CORC

EASTERN:

Wheat:

$$LD_{we} = 5.24 + .51LY_e - .55LP_{we}$$

t: (10.46) (4.41) (4.32)

$R^2 = .62$ D = 1.85 Type = OLS

Rice:

$$LD_{re} = 1.80 + .58LY_e - .34LP_{re}$$

t: (1.64) (3.03) (1.61)

$R^2 = .93$ D = 1.77 Type = CORC

Maize:

$$LD_{ce} = 5.73 + .28LY_e$$

t: (20.99) (9.41)

$R^2 = .87$ $D = 1.25$ Type = OLS

Millet:

$$LD_{me} = 7.49 + .01LY_e - .03LP_{me}$$

t: (7.49) (.88) (1.28)

$R^2 = .93$ $D = 1.95$ Type = CORC

Sorghum:

$$LD_{se} = 6.87 + .19LY_e - .11LP_{se}$$

t: (11.83) (1.87) (.89)

$R^2 = .66$ $D = 2.34$ Type = CORC

Roots:

$$LD_{re} = 6.93 + .29LY_e$$

t: (38.89) (14.61)

$R^2 = .96$ $D = .95$ Type = CORC

Pulses:

$$LD_{pe} = 7.09 - .02LY_e$$

t: (5.34) (0.16)

$R^2 = .75$ $D = .83$ Type = CORC

SOUTHERN

Wheat:

$$LD_{ws} = 6.10 + 1.46LY_s - .55LP_{ws}$$

t: (11.60) (6.21) (3.09)

$R^2 = .85$ D = 1.52 Type = OLS

Rice:

$$LD_{rs} = 7.33 + .56LY_s - .15LP_{rs}$$

t: (5.81) (1.67) (.39)

$R^2 = .56$ D = 1.40 Type = OLS

Maize:

$$LD_{cs} = 7.54 + .35LY_s$$

t: (70.92) (5.34)

$R^2 = .89$ D = 1.38 Type = OLS

Millet and Sorghum:

$$LD_{ms} = 7.08 - .17LY_s$$

t: (70.61) (3.10)

$R^2 = .43$ D = 1.59 Type = OLS

Roots:

$$LD_{rs} = 8.93 - .15LY_s$$

t: (60.10) (2.05)

$R^2 = .98$ D = 1.04 Type = CORC

Pulses:

$$LD_{ps} = 4.13 + .002LY_s$$

t: (9.14) (.11)

$R^2 = .92$ D = 1.12 Type = CORC

Appendix table 6--Projection demand assumptions

Projection	Growth in per capita income	Growth in Population	Income Elasticities
75	No increase above real 1975 levels	UN medium variant	Estimated--
79	No increase above real 1979 levels	UN medium variant	Estimated.
65	Increases follow trend for 1965-79 period--implied rates are -1.4% for Sahel, 4.0% for West, 2.3% for Central, 1.15% for East and -1.48% for Southern	UN medium variant	Estimated--
74	Increases follow trend for 1974-79--implied growth rates are -2.7% for Sahel, 4.56% for West and 2.03% for Central, 1.2% for East -3.71% for Southern.	UN medium variant	Estimated
FPRI			
Constant--1975 per capita	No real growth--1975 per capita income levels maintained	UN medium variant	FAO estimates
low	Limited income growth --dampened by high oil prices. Growth rates are approximately: 6.3% Nigeria 0.5%-0.9% for poorest countries 2.0%-2.5% others	UN medium variant	FAO estimates
high	Income growth recovers for economic slump. Growth rates are approximately: 8.4% Nigeria 1.5% poorest 3.0%-3.5% others		
AO			
trend	Optimistic growth rates--6.5% per year (includes N. Africa)	UN medium variant	FAO estimates
MPD	1961-75 trend adjusted upward	UN medium variant	FAO estimates
OL	Unadjusted trend, implying 0.5% annual increase	UN medium variant	Model estimates
OIRA			
high growth, greater equality	6%--growth on non-agricultural GDP	Rapid fertility decline	Model calculates
low growth	3%--growth in non-agricultural	Rapid fertil-	Model calculates

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Appendix table 7 --Projection production assumptions

Projection	Production specification	Rate of production
C75	Production projected from equations; constant 1975 real prices assumed.	1.65%; Sahel, 1.32%; West 1.02%, Central, 3.79%; Eastern, 1.52%; South, 1.59%
C79	Production projected from equations; constant 1979 real prices assumed.	1.50%; Sahel, 0.80%; West, 0.82%; Central, 3.79%; Eastern, 1.27%; South, 1.75%
T65	Production projected from equations; real prices follow 1965-79 trend.	1.66%; Sahel, 1.4%; West, .95%; Central, 3.79%; Eastern, 1.73%; Southern, 1.47%
T74	Production projected from equations; real prices follow 1974-79 trend.	1.67%; Sahel, 1.0%; West, 0.8%; Central, 3.79%; Eastern, 1.67%; Southern, 1.81%.
IFPRI	No change in production growth rate-- rate--set at 1960-75 baseline	1.6% (cereal production)
FAO		
trend	Trend projection adjusted upward by assuming oil producing countries maintain recent growth rates and MSA's grow faster in 1970-75.	2.8%
MPD	Production equals demand unless this figure exceeds FAO's "maximum feasible production". Then production equals maximum feasible production.	3.5%-5.1% (cereal production)
GOL	Food production is calculated by the model. It depends on the relative crop prices and input prices as well as physical production relations.	2.0% (grain production)
MOIRA	Agricultural production is calculated by the model. It depends on the price of food and input prices as well as on physical production processes.	
low growth		1.3%
high growth		4.2%

Appendix table 8 --Comparative supply projections by region 1/

	Cereal							
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
Sahel								
Trend FAO 1985	20.0	597.0	235.0	4,473.0	5,325.0	246.8	520.0	6,091.8
FAO 1990 MPD	122.0	1,454.0	369.0	6,212.0	8,157.0	793.3	853.0	9,803.3
IFPRI 1975	---	---	---	---	---	---	---	4,120.0
IFPRI Low	---	---	---	---	---	---	---	4,120.0
IFPRI high	---	---	---	---	---	---	---	4,120.0
C75	---	598.6	215.9	4,753.3	5,567.8	235.9	118.6	5,922.3
C79	---	563.6	209.9	4,465.4	5,238.9	235.9	118.6	5,993.4
T65	---	576.5	214.5	4,661.6	5,452.6	235.9	118.6	5,807.1
T74	---	531.8	211.5	4,611.2	5,354.5	235.9	118.6	5,709.0
West								
Trend FAO 1985	20.0	2,707.0	3,519.0	9,045.0	15,291.0	13,883.1	1,056.0	30,230.0
FAO 1990 MPD	27.0	4,609.0	5,638.0	11,617.0	21,891.0	16,552.8	2,047.0	40,490.8
IFPRI 1975	---	---	---	---	---	---	---	29,912.0
IFPRI low	---	---	---	---	---	---	---	29,912.0
IFPRI high	---	---	---	---	---	---	---	29,912.0
C75	---	2,886.9	3,279.0	3,233.0	9,398.0	14,996.1	102.3	24,496.4
C79	---	2,493.7	3,135.7	3,233.0	8,862.4	14,996.1	102.3	23,960.8
T65	---	2,674.6	3,295.0	3,233.0	9,202.6	14,996.1	102.3	24,301.0
T74	---	2,189.0	3,243.1	3,233.0	8,665.1	14,996.1	102.3	23,763.5
Central								
Trend FAO 1985	14.0	351.0	1,134.0	259.0	1,758.0	4,850.9	343.0	6,951.9
FAO 1990 MPD	20.0	667.0	1,762.0	357.0	2,806.0	6,762.3	464.0	10,032.3
IFPRI 1975	---	---	---	---	---	---	---	9,764.0
IFPRI low	---	---	---	---	---	---	---	9,764.0
IFPRI high	---	---	---	---	---	---	---	9,764.0
C75	---	236.8	1,720.7	162.7	2,120.2	8,883.4	182.3	11,185.9
C79	---	236.8	1,720.7	162.7	2,120.2	8,883.4	182.3	11,185.9
T65	---	236.8	1,720.7	162.7	2,120.2	8,883.4	182.3	11,185.9
T74	---	236.8	1,720.7	162.7	2,120.2	8,883.4	182.3	11,185.9
East								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1990 MPD	---	---	---	---	---	---	---	---
IFPRI 1975	---	---	---	---	---	---	---	27,967.0
IFPRI low	---	---	---	---	---	---	---	27,967.0
IFPRI high	---	---	---	---	---	---	---	27,967.0
C75	747.9	500.8	6,576.4	6,677.4	14,502.5	6,295.0	916.0	21,713.5
C79	747.9	379.8	6,286.5	6,491.9	13,906.1	6,295.0	916.0	21,117.1
T65	747.9	457.5	6,856.8	6,912.5	14,974.7	6,295.0	916.0	22,185.7
T74	747.9	483.0	6,728.1	6,902.0	14,861.4	6,295.0	916.0	22,072.0

--continued

Appendix table 8 --Comparative supply projections by region 1/ --continued

	Cereals							
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
<u>Southern</u>								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1980 MPD	---	---	---	---	---	---	---	---
IFPRI 1975	---	---	---	---	---	---	---	10,529.0
IFPRI low	---	---	---	---	---	---	---	10,529.0
IFPRI high	---	---	---	---	---	---	---	10,529.
C75	119.9	2,760.3	6,332.1	656.6	9,868.9	1,751.3	46.2	11,666.
C79	119.9	2,689.7	6,586.9	649.2	10,045.3	1,751.3	46.2	11,842.2
T65	119.9	2,677.3	6,271.1	643.2	9,711.5	1,751.3	46.2	11,509.
T74	119.9	2,740.3	6,945.1	676.3	10,481.6	1,751.3	46.2	12,279.
<u>East and South</u>								
Trend FAO 1985	1,469.0	3,096.0	10,667.0	4,741.0	19,973.0	6,132.3	2,249.0	28,354.
FAO 1980 MPD	2,722.0	4,904.0	15,130.0	7,097.0	29,853.0	7,844.1	3,439.0	41,136.1
IFPRI 1975	---	---	---	---	---	---	---	38,496.
IFPRI low	---	---	---	---	---	---	---	38,496.
IFPRI high	---	---	---	---	---	---	---	38,496.0
C75	---	---	---	---	---	---	---	33,379.
C79	---	---	---	---	---	---	---	32,959.
T65	---	---	---	---	---	---	---	---
T74	---	---	---	---	---	---	---	---
<u>Total all regions</u>								
Trend FAO 1985								71,628.
FAO 1980 MPD								101,462.
IFPRI 1975								82,292.0
IFPRI low								82,292.0
IFPRI high								82,292.
C75								72,720.
C79								71,087.2
T65								72,376.
T74								61,211.

Appendix table 9 --Comparative demand projections by region 1/

	Cereal							
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
hel								
Trend FAO 1985	297	1,042.0	386.0	5,382.0	7,107.0	289.2	580.0	7,976.2
FAO 1990 MPD	522	1,456.0	354.0	6,434.0	8,766.0	381.9	796.0	9,943.9
IFPRI 1975	---	---	---	---	---	---	---	7,212.0
IFPRI Low	---	---	---	---	---	---	---	7,386.0
IFPRI high	---	---	---	---	---	---	---	7,676.0
C75	596.3	2,067.6	261.0	3,902.4	6,827.3	220.0	97.0	7,144.3
C79	480.3	1,756.1	221.5	3,794.8	6,252.7	223.1	101.6	6,577.4
T65	485.8	1,882.8	236.3	3,842.6	6,447.5	224.0	99.9	6,771.4
T74	527.4	1,919.7	216.4	3,850.7	6,514.2	225.5	102.3	6,842.0
st								
Trend FAO 1985	1,425.0	3,421.0	3,859.0	9,742.0	18,447.0	14,351.1	1,444.0	34,141.0
FAO 1990 MPD	2,648.0	4,685.0	5,643.0	11,618.0	24,594.0	16,507.8	1,951.0	42,916.2
IFPRI 1975	---	---	---	---	---	---	---	39,148.0
IFPRI low	---	---	---	---	---	---	---	47,555.0
IFPRI high	---	---	---	---	---	---	---	51,373.0
C75	3,749.9	3,340.9	3,196.6	3,332.8	13,620.2	15,968.7	186.9	29,775.8
C79	3,741.3	4,279.3	3,214.7	3,300.0	14,534.3	15,864.9	178.7	30,578.9
T65	6,793.5	5,782.1	3,477.6	3,518.8	19,572.0	16,352.1	240.8	36,164.9
T74	8,352.4	9,743.9	3,549.7	3,544.3	25,190.3	16,492.0	249.1	41,931.4
ntral								
Trend FAO 1985	585.0	570.0	1,385.0	284.0	2,824.0	17,096.4	357.0	8,481.0
FAO 1990 MPD	980.0	973.0	1,973.0	334.0	4,260.0	17,522.0	446.0	10,137.8
IFPRI 1975	---	---	---	---	---	---	---	8,184.0
IFPRI low	---	---	---	---	---	---	---	8,725.0
IFPRI high	---	---	---	---	---	---	---	8,876.0
C75	730.3	435.6	1,695.1	185.3	3,046.3	7,397.8	191.0	10,636.0
C79	747.1	463.8	1,833.2	193.4	3,237.5	7,333.7	190.7	10,761.9
T65	892.6	412.9	2,080.0	202.1	3,587.6	7,094.6	154.1	10,836.3
T74	872.1	450.8	2,006.9	207.4	3,537.2	7,136.2	156.0	10,829.4
st								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1990 MPD	---	---	---	---	---	---	---	---
IFPRI 1975	---	---	---	---	---	---	---	27,892.0
IFPRI low	---	---	---	---	---	---	---	30,726.0
IFPRI high	---	---	---	---	---	---	---	31,437.0
C75	1,781.7	451.8	6,737.0	5,858.0	14,828.5	7,984.2	958.3	23,771.0
C79	1,694.7	512.2	6,382.0	5,934.0	14,522.9	7,764.4	971.3	23,258.6
T65	1,068.2	537.7	7,413.3	6,066.1	15,085.3	8,601.6	956.0	24,950.1
T74	1,020.7	515.9	7,432.4	6,065.3	15,034.3	8,933.4	955.8	24,615.6

--continued

Appendix table 9 --Comparative demand projections by region 1/ --continued

	Cereals							
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
Southern								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1980 MPD	---	---	---	---	---	---	---	---
IFPRI 1975	---	---	---	---	---	---	---	11,467.[illegible]
IFPRI low	---	---	---	---	---	---	---	11,810.0
IFPRI high	---	---	---	---	---	---	---	11,931.[illegible]
C75	2,440.0	4,314.0	6,216.0	664.9	13,634.8	1,403.4	62.6	15,100.[illegible]
C79	1,396.0	3,356.0	5,520.0	723.7	10,995.7	1,512.5	62.5	12,570.7
T65	2,181.3	4,339.4	6,073.6	675.7	13,270.0	1,471.6	62.0	14,803.6
T74	1,325.3	3,083.6	4,984.4	826.8	10,220.1	1,591.6	61.9	11,873.[illegible]
East and South								
Trend FAO 1985	2,677.0	3,752.0	11,854.0	5,636.0	23,919.0	6,564.4	2,453.0	32,936.[illegible]
FAO 1980 MPD	3,988.0	4,818.0	14,110.0	6,982.0	29,928.0	7,458.9	3,132.0	40,518.9
IFPRI 1975	---	---	---	---	---	---	---	39,359.[illegible]
IFPRI low	---	---	---	---	---	---	---	42,536.[illegible]
IFPRI high	---	---	---	---	---	---	---	43,368.0
C75	---	---	---	---	---	---	---	38,871.8
C79	---	---	---	---	---	---	---	35,829.[illegible]
T65	---	---	---	---	---	---	---	39,753.[illegible]
T74	---	---	---	---	---	---	---	36,489.2
Total all regions								
Trend FAO 1985								83,534.6
FAO 1980 MPD								103,516.[illegible]
IFPRI 1975								93,903.[illegible]
IFPRI low								106,202.0
IFPRI high								111,293.[illegible]
C75								83,296.[illegible]
C79								80,637.0
T65								89,504.9
T74								92,366.[illegible]

Appendix table 10--Comparative import gap projections by region 1/

	Cereal					:	:	:
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
ahel								
Trend FAO 1985	---	---	---	---	---	---	---	-1,884.4
FAO 1990 MPD	---	---	---	---	---	---	---	-140.6
IFPRI 1975	---	---	---	---	---	---	---	-3,092.0
IFPRI Low	---	---	---	---	---	---	---	-3,266.0
IFPRI high	---	---	---	---	---	---	---	-3,556.0
C75	-596.3	-1,468.9	-45.1	+850.9	-1,259.4	+15.9	+21.6	-1,222.0
C79	-480.3	-1,192.5	-11.6	+670.6	-1,014.4	+12.8	+17.0	-984.6
T65	-485.8	-1,306.3	-21.8	+819.0	-994.9	+11.9	+17.4	-964.3
T74	-527.4	-1,387.8	-4.9	+760.5	-1,159.7	+10.4	+15.2	-1,133.0
est								
Trend FAO 1985	---	---	---	---	---	---	---	-3,910.9
FAO 1990 MPD	---	---	---	---	---	---	---	-2,425.4
IFPRI 1975	---	---	---	---	---	---	---	-9,236.0
IFPRI low	---	---	---	---	---	---	---	-17,643.0
IFPRI high	---	---	---	---	---	---	---	-21,461.0
C75	-3,749.9	-454.9	+82.4	-99.8	-4,222.2	-972.6	-84.6	-5,279.4
C79	-3,741.3	-1,785.6	-79.0	-67.0	-5,672.9	-868.8	-76.4	-6,558.1
T65	-6,793.5	-3,107.5	182.6	-285.8	-10,369.4	-1,356.0	-138.5	-11,863.9
T74	-8,352.4	-7,554.9	-306.6	-311.3	-16,525.2	-1,495.8	-146.8	-18,167.9
entral								
Trend FAO 1985	---	---	---	---	---	---	---	-1,529.1
FAO 1990 MPD	---	---	---	---	---	---	---	-105.5
IFPRI 1975	---	---	---	---	---	---	---	+1,580.0
IFPRI low	---	---	---	---	---	---	---	+1,039.0
IFPRI high	---	---	---	---	---	---	---	+888.0
C75	-730.3	-198.8	+25.6	-22.6	-926.1	1,485.5	-9.6	+549.8
C79	-747.1	-227.0	-12.5	-30.7	-1,117.3	1,549.7	-8.4	+424.0
T65	-892.6	-176.1	-359.2	-39.4	-1,467.6	1,788.7	+28.2	+349.6
T74	-871.1	-214.0	-286.3	-44.6	-1,417.2	1,747.2	+26.3	356.5
ast								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1990 MPD	---	---	---	---	---	---	---	---
IFPRI 1975	---	---	---	---	---	---	---	+75.0
IFPRI low	---	---	---	---	---	---	---	-2,759.0
IFPRI high	---	---	---	---	---	---	---	-3,470.0
C75	-1,033.8	+49.0	-160.6	819.4	-326.0	-1,689.2	-42.3	-2,057.6
C79	-946.8	-132.4	-95.5	557.9	-616.8	-1,469.4	-55.3	-2,141.5
T65	-320.3	-80.2	-556.5	845.9	-111.1	-2,306.6	-40.0	-2,457.7
T74	-272.8	-32.9	-704.3	836.7	-173.3	-2,638.4	-39.8	-2,543.6

--continued

Appendix table 10 --Comparative import gap projections by region 1/ --continued

	Cereals							
	Wheat	Rice	Maize	Millet/ sorghum	Total	RTP	Pulses	Grand total
Southern								
Trend FAO 1985	---	---	---	---	---	---	---	---
FAO 1980 MPD	---	---	---	---	---	---	---	--
IFPRI 1975	---	---	---	---	---	---	---	-938.[illegible]
IFPRI low	---	---	---	---	---	---	---	-1,281.0
IFPRI high	---	---	---	---	---	---	---	-1,402.6
C75	-2,320.1	-1,553.7	+116.1	-8.4	-3,766.1	374.9	-16.4	-3,434.[illegible]
C79	-1,276.1	-666.3	+1,066.9	-74.5	-950.0	238.8	-16.3	-727.9
T65	-2,061.4	-1,662.1	+197.6	-365.0	-3,558.4	279.7	-15.8	-3,294.6
T74	-1,205.3	-343.3	+1,960.7	-150.5	+261.5	159.7	-15.7	+405.[illegible]
East and South								
Trend FAO 1985	-1,208.0	-656.0	-1,187.0	-895.0	-3,946.0	432.1	-204.0	-4,582.[illegible]
FAO 1980 MPD	-1,266.0	-86.0	-1,020.0	+115.0	-75.0	+385.2	+307.0	+617.2
IFPRI 1975	---	---	---	---	---	---	---	-863.0
IFPRI low	---	---	---	---	---	---	---	-4,040.[illegible]
IFPRI high	---	---	---	---	---	---	---	-4,872.6
C75	---	---	---	---	---	---	---	-5,492.0
C79	---	---	---	---	---	---	---	-2,869.[illegible]
T65	---	---	---	---	---	---	---	-6,058.[illegible]
T74	---	---	---	---	---	---	---	-2,138.1
Total all regions								
Trend FAO 1985								-11,906.5
FAO 1980 MPD								-2,054.[illegible]
IFPRI 1975								-11,611.0
IFPRI low								-23,910.0
IFPRI high								-29,001.6
C75								-11,489.[illegible]
C79								-10,231.8
T65								-18,537.6
T74								-21,082.[illegible]

Appendix Table 11--Expected yield for different crops, Sub-Saharan Africa

Region	Wheat	Rice	Maize	Millet	Sorghum	Roots	Pulses
				MT/ha.			
Sahel	NP	1.185	.725	.520	2/	5.985	.124
Western	NP	1.227	.911	.602	NA	7.982	.446
Central	NP	.574	.715	.653	2/	6.442	.569
Eastern	.913	1.254	1.025	.672	.852	6.70	.666
Southern	1.263	1.824	1.215	.674	.970	5.696	.482

NP = Not produced significantly.
NA = Not available
1/ The expected yield was calculated using probability distribution of yield 1965-79.
2/ Combined with millet.

REFERENCES

REFERENCES

Abu-Lughod, J. and Richard Hay, Jr. "Underdevelopment and Dependence in Black Africa - Origins and Contemporary Forms," Third World Urbanization. Ed. Samir Anin. Chicago: Mauroufa Press, 1977.

Ancey, G. "Niveaux de Décision et Fonctions Objectives en Milieu Rural Africain, "AMIRA, No. 3 (1975).

Anschel, Kurt R. and Russel H. Brannon. "The Agricultural Sector of Namibia: A Brief Assessment." Aug. 1978. Prepared for Southern Africa Development Analysis Project, USDA.

Arraudeau, M. "Rice Breeding in the Malagasy Republic," Rice in Africa. Eds. I.W. Buddenhagen and G.J. Persley. New York: Academic Press, 1978.

Barker, Randolph and Yujiro Hayami. "Price Support Versus Input Subsidy In Food Self-Sufficiency in Developing Countries," American Journal of Agricultural Economics, Vol. 58, No. 4 (Nov. 1976), 617-628.

Bates, R. Political Economy of Agricultural Policy in Africa (tenative title) Draft manuscript, 1979.

Berry, Sara. Cocoa, Custom and Socio-Economic Change in Rural Western Nigeria. Clarendon, England: Oxford University Press, 1975.

Beyrard, N. Programme Intégré deDéveloppement du Bassin du Sénégal. UNDP, Volume V. Paris, 1974.

Botswana Agricultural Marketing Board. "Fifth Annual Report 1979."

Botswana, Ministry of Finance and Development Planning. National Development Plan 1976-1981. 1977.

Brett, E.A., Colonization and Underdevelopment in East Africa.London: Heinemann, 1973.

Brown, G.T. "Agricultural Pricing Policies and Economic Growth," Finance and Development, IMF (Dec. 1977), 42-45.

Cabot, J. and Christian Bouquet. Le Tchad. Paris, France: Presses Universitaries de France, 1973.

Center for Research on Economic Development. Mali: Agricultural Sector Assessment. Ann Arbor, Michigan: University of Michigan, Dec. 1976.

Marketing, Price Policy and Storage of Food Grains in the Sahel Vol. I and II. Ann Arbor, Michigan: University of Michigan, Aug. 1977.

Christensen, C. "The Right to Food: How to Guarantee Alternatives, A Journal of World Policy, Vol. 4, No. 2 (Oct. 1978), 181-220.

Comité Inter-Etats pour la Lutte contre la Sécheresse dans le Sahel (CILSS). Various documents. Ouagadougou, Upper Volta.

Coulson, A.C. "Tanzania's Fertilizer Factory," Journal of Modern African Studies, Vol. 15, No. 1 (March 1977), 119-125.

Council on Environmental Quality and Department of State. The Global 2000 Report to the President. Volume 2. Washington, D.C., May 1980.

Cummings, R.W. "Food Crops in the Low-Income Countries: The State of Present and Expected Agricultural Research and Technology," New York: Rockefeller Foundation, May 1976.

Dalrymple, D.G. Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less-Developed Nations. U.S. Dept. of Agr., Econ. Stat. Coop. Serv., 1978.

Delgado, C.L., and John McIntire. "Economic Constraints on Farming with Plow Oxen in the Sahel," mimeographed, July 1980.

Dunlop, J. and Kenneth Fedor (Eds). The Lessons of Wage and Price Controls - The Food Sector. Cambridge, Mass.: Harvard University Press, 1977.

Enger W. "The Government of Niger's Agricultural Strategy and the Potential for Meeting Long-term Goals," Niger Agricultural Sector Assessment, January 1980.

FAO. "The Economics and Planning of Irrigation: Report to the Government of Tanzania," Rome: FAO, 1972.

__________. Report on the Agro-Ecological Zones Project. Vol. 1. Methodology and Results for Africa. Rome: FAO, 2978.

__________. Regional Food Plan for Africa. Rome FAO, 1978.

__________. Production Yearbook. Rome: FAO, 1978.

__________. Fertilizer Yearbook. Rome: FAO, 1978.

__________. Trade Yearbook . Rome: FAO, 1978.

__________ /UNESCO. Soil Map of the World, 1:5,000,000; Vol. VI, Africa. Paris: UNESCO, 1977.

__________. World Conference on Agrarian Reform and Rural Development. Country Review Papers for vrious countries. Rome.: FAO, 1978.

Fifth Lok Sabha, Estimates Committee, Fortieth Report, Fertilizer. New Delhi: Lok Sabha Secretariat, 1973.

Gahamanyi, L. "La Politique Nationale Agricole," Bulletin Agricole de

Rwanda, (April 1977), 91-95.

Georges, M., and others. "Wheat Production at Lake Chad," Agricultural Development Projects in Francophone Africa.

Gerhart, J. "The Diffusion of Hybrid Maize in Western Kenya," Mexico City: CIMMYT, 1975.

Gatahun, Amare. "Agricultural Systems in Ethiopia," Agricultural Systems, Vol. 3, No. 4 (Oct. 1978), 281-290.

Grist, D.H. Rice. London, England: Longman, 5th edition, 1975.

Harriss, B. Cereals Surpluses in the Sudano-Saheelian States, Vols. 1 and 2. Report submitted to ICRISAT, Hyderabad-Hyderabad, India: ICRISAT, 1978.

Hesselmark, Olof and Gunter Lorenzl. "Structure and Problems of the Maize Marketing System in Kenya," Zeitschrift für ausländische Landwirt-schaft, Vol. 15, No. 2 (April-June 1976), 161-178.

Hill, Polly. The Migrant Cocoa Farmers of Southern Ghana. Cambridge, England: Cambridge University Press, 1963.

Hopkins, E. "Wolof Farmers in Senegal: A Study of Responses to an Agricultural Extension Scheme," Unpublished Ph.D. dissertation, University of Sussex, 1975.

Hopkins, R. and D. Puchala. The Political Economy of Food. Madison, Wisconsin: University of Wisconsin Press, 1979.

International Bank for Reconstruction and Development. Various documents.

International Fertilizer Development Center. West African Ferilizer Study Vols. I-VII. Alabama: IFDC, 1977.

International Food Policy Research Institute. Food Needs of Developing Countries: Projections of Production and Consumption to 1990. Washington, D.C.: IFPRI, 1977.

International Institute of Tropical Agriculture, "Research and Training Activities at IITA," Sept. 1979.

International Monetary Fund. Various documents.

Jabara, C. and Robert Thompson. "Agricultural Comparative Advantage Under International Price Uncertainty: The Case of Senegal," American Journal of Agricultural Economics, Vol. 62, No. 2 (May 1980).

Jain, S. Size of Income Distribution. Washington, D.C.: World Bank, 1975.

Kassam, A.H. Crops of the West AfricanSemi-Arid Tropics. Hyderabad, India: ICRISAT, 1976.

J.M. Kowal. Agricultural Ecology of Savanna: A Study of West Africa. Oxford, England: Oxford University Press, 1978.

Kenya, Government of. Development Plan 1979 to 1983. [Nairobi] Feb.: 1979.

Leakey, C.L.A, and J.B. Wills eds. Food Crops of the Lowland Tropics. Oxford, England: Oxford University Press, 1977.

Lele, Uma. "A Revisit to Rural Development in Eastern Africa," Finance and Development, Vol. 16, No. 4 (Dec. 1979) 31-35.

Leys, C. Underdevelopment in Kenya. London: Heinemann, 1975.

Leontief, W. and others. The Future of the World Economy: A United Nations Study. Oxford, England: Oxford University Press, 1977.

Lijoodi, J. L. and Hans Ruthenberg. "Income Distribution in Kenya's Agriculture. "Zeitschrift für ausländische Landwirtschaft, Vol. 17, No. 2 (April-June 1978), 115-128.

Linneman, H., and others. MOIRA: Model of International Relations in Agriculture. Amsterdam: North Holland, 1979.

Lipton, M. Why the Poor Stay Poor? Urban Bias in World Development. Cambridge, Mass., Harvard University Press, 1977.

Lofchie, Michael F. "Political and Economic Origins of African Hunger," The Journal of Modern African Studies, Vol. 13, No. 4 (Dec. 1975), 551-567.

________________. "Agrarian Crisis and Economic Liberalization in Tanzania," The Journal of Modern African Studies, Vol. 16, No. 3 (Sept 1978), 451-475.

Lott, Charlotte E. Land Concentration in the Third World: Statistics on Number and Area of Farms Classified by Size of Farms. Madison, Wisconsin: Land Tenure Center, University of Wisconsin, April 1979.

Malecela, John. "Self Sufficiency." Ceres, Vol. 12, No. 1, (Jan.-Feb. 1979), 22-28.

Mesarovic, M. and Eduard Pestel. Mankind at the Turning Point: The Second Report to the Club of Rome. New York: Dutton, 1974.

Moore, John and others. "An Agricultural Sector Assessment of Malawi." Sept. 1978. Prepared for Southern Africa Development Analysis Project, USAID.

Motheral, Joseph and others. "Agricultural Sector Assessment: Botswana." Aug. 1978. Prepared for Southern Africa Development Analysis Project, USAID.

National Academy of Sciences. World Food and Nutrition Study: The Potential Contribution of Research. 1977.

Nigeria, Federal Ministry of Agriculture, "The Green Revolution: A Food Production Plan for Nigeria," Vol. 2., Lagos, May 1980.

Norman, D. "Economic Rationality of Traditional Mausa Dryland Farmers in the North of Nigeria," Tradition and Dynamics in Small-Farm Agriculture. Ed. Robert D. Stevens. Ames: Iowa University Press, 1977.

Norman, D., I. Ouedraogo, and M. Newman. The Farmer in the Semi-Arid Tropics of West Africa Vol. I and II. Hyderabad, India: ICRISAT, 1977.

Nwafor, James C. "Constraints on Agricultural Planning and Development in Rwanda: An Overview," African Environment, Vol. 2 and 3, No.4 and 1 (Nov. 1977), 87-95.

Oram, P., and others. Investment and Input Requirements for Accelerating Food Production in Low-Income Countries by 1990. Washington, D.C.: IFPRI, Dec. 1979.

Otzen, Uwe. "Agricultural Changes in Rhodesia (Zimbabwe) - Effects of Economic Sanctions," Zeitschrift für ausländische Landwirtschaft, Vol. 17, No. 2 (April - June 1978), 100-114.

Palmer, Robin and Neil Parson (Eds.). The Roots of Rural Poverty in Central and Southern Africa. Berkley: University of California Press, 1977.

Papadakis, J. Climates of the World and Their Agricultural Potentialities. Buenos Aires: Papadakis, 1966.

Population Reference Bureau, Inc. "1978 World Population Data Sheet," Washington, D.C., 1979.

____________. "World Population Growth and Response, 1965-75: A Decade of Global Action," Washington, D.C.

Raikes, Philip. "Agrarian Crisis and Economic Liberalisation in Tanzania: a Comment," The Journal of Modern African Studies, Vol. 17, No. 2 (June 1979), 309-316.

Reutlinger, S., and Marcelo Selowsky. Malnutrition and Poverty. Baltimore: Johns Hopkins Press, 1976.

Robbins, Richard D. "The Agricultural Sector of Zimbabwe." Aug. 1978. Prepared for Southern Africa Development Analysis Project, USAID.

Ross, C. Grain Demand and Consumer Preferences-Dakar, Senegal. CRED. Ann Arbor, Michigan: University of Michigan, June 1979.

Rotberg, Robert and Ali Mazrui (Ed). Power and Protest in Africa. Oxford, England: Oxford University Press, 1970.

Ruthenberg, Hans. Farming Systems in the Tropics. 2nd. ed. Oxford, England: Oxford University Press, 1976.

Ruttan, V. W. "Usher and Schumpeter on Invention, Innovation and Technical Change," The Quarterly Journal of Economics, Vol. 73, No. 4 (November 1959).

Saleh, Abdullah and O. Halbert Goolsby. "Institutional Disincentives to Agricultural Production in Developing Countries," Foreign Agriculture. U.S. dept. Agr., For. Agri. Serv., Aug. 1977.

SCET. "Outline of Water Resources Development in the West African Sahel," SCET-International.

Seers, Dudley and others. The Rehabilitation of the Economy of Uganda. London: Commonwealth Secretariat, 1979.

Senegal, Government of, Ministry of Agriculture. National Investment Strategy for Increasing Food Production, Senegal. 1977.

Simmons, Richard L. "Mozambique: An Economic Base Study with Emphasis on Agriculture," Aug. 1978. Prepared for Southern Africa Development Analysis Project, USAID.

Stallings, James. "Agricultural Sector Assessment, Swaziland." [Aug. 1978] Prepared for Southern Africa Development Analysis Project, USAID.

Tanzania, Ministry of Agriculture. Surplus Sorghum, Millet and Cassava. Dar es Salaam, 1979.

Tuthill, Dean F. and others. "Agricultural Sector Assessment, Zambia," Aug. 1978. Prepared for Southern Africa Development Analysis Project, USAID.

United Nations. World Housing Survey, Report of The Secretary General. New York: UN. 1973.

United Nations. Preliminary Assessment of the World Food Situation, Present and Future. Rome: UN, 1974.

United Nations. World Population Trends and Policies 1977 Monitoring Report. New York: UN, 1977.

U.S. Agency for International Development. P.L. 480 Title III Program for Senegal. Mimeo. , 1979.

__________. Development Needs and Opportunities for Cooperation in Southern Africa. March 1979.

__________. Africa Bureau. Agriculture/Rural Development Functional Review. July 1979.

__________. Niger: Agriculture Sector Assessment. Niamey, Niger: October 1979.

__________. Kitale Maize: The Limits of Success. Dec. 1979.

__________. Kenya, U.S. Mission Recommendations for P.L. 480 Title I Assistance, FY 1980.

U.S. Department of Agriculture, Economics, Statistics and Cooperatives Services. Structural Issues of American Agriculture. AER-438. Nov. 1979.

__________, World Analysis Branch. "Foreign Exchange and International Price Developments." Staff Report. March 1980.

__________. Indices of Agricultural Production in Africa and the Near East. SB-637. June 1980.

__________. Gasohol Prospects and Implications. AER-458. June 1980.

Valdes, Alberto and Barbara Huddleston. Potential of Agricultural Exports to Finance Increased Food Imports in Selected Developing Countries. Occasional Paper 2. Washington, D.C.: IFPRI, 1977.

West African Rice Development Association. Prospects and Costs of Achieving Self-Sufficiency in Rice Production in West Africa by 1980. Liberia: WARDA, Oct. 1979.

__________. Various country studies, 1979.

__________ and Food Research Institute. The Political Economy of Rice in West Africa: A Summary of Principal Results. Mimeograph, July 1979.

White, T. K. "An Overview of Dry Land Farming Research Activities," paper prepared for the Workshop on Sahelian Agriculture, Purdue University, February 1979.

Wilcock, D. C. Political Economy of Grain Marketing and Storage in the Sahel. Working Paper, No. 24. East Lansing: African Rural Economy Program, Michigan State University, 1978.

World Bank. World Development Report 1979 and 1980. Washington D.C.: World Bank 1979, 1980.

Zalla, T., R. B. Diamond, and M. S. Mudahar. Economic and Technical Aspects of Fertilizer Production and Use in West Africa. Working Paper, No. 22. East Lansing: African Rural Economy Program, Michigan State University, p. 77.

Zambia, Office of the President, National Commission for Development Planning. "Zambia Economic Report 1979" Lusaka, Jan. 1980.